SECTION 18

STABILISING AMPLIFIERS: AM18 SERIES

AMPLIFIERS AM18/509 TO AM18/509E

Introduction

The AM18/509 is a shunt clamp amplifier designed to clamp the back-porch voltage of a video signal to earth. It has input and output impedances of 75 ohms and accepts composite signals at a level of 1 volt peak-to-peak. The main video signal path through the equipment is composed of passive elements only, and signals are passed with good linearity, although with a loss of 3 dB. Operation can be on any of the normal television line standards; when the input is not a 405-line signal, an automatic internal adjustment occurs to suit either 625-line or 525-line and 819-line waveforms.

The principal intended application of the equipment is in complex transmission systems, where it is used to reduce spurious variations in the d.c. level of the signal; the equipment is not intended to be used for the correction of badly distorted signals, such as might be encountered at the ends of such systems, and it does not provide sync-pulse amplitude stabilisation or automatic time-constant control.

The AM18/509 consists of a stabilising amplifier AM18/508, an error signal amplifier AM3/501, and a sampling pulse generator GE2/502; these are plugged into a rack-mounting panel PN3/21, in which they occupy one half of the width.

The AM18/509A comprises two shunt clamps, separately identical to an AM18/509, which together fill a PN3/21 panel.

The AM18/509B and AM18/509C are identical to the AM18/509 and AM18/509A respectively, except that each uses a flush-mounting panel PN3/23.

The AM18/509D is similar to the AM18/509C, but with the addition of output switching relays and associated components mounted at the rear. The relays are used to provide a make-before-break change-over switching system; this enables cuts to be made between the outputs of the two constituent clamps, which are fed with different video signals (e.g., from telecine machines operating in a duplex mode).

The AM18/509E is similar to the AM18/509B but includes a gain-control unit UN3/507 and a 15-dB amplifier AM5/507. With the inclusion of the AM5/507, the main video signal path no longer comprises passive elements only, and the AM18/509E has a gain which can be adjusted continuously over the range −3 dB to +3 dB. It is expected that the AM18/509E will usually be operated with a composite video input of 1 volt peak-to-peak. However, a non-composite signal of 0·7 volt peak-to-peak can be applied to the clamping circuits via the normal video inlet while a mixed sync signal of 2 volts peak-to-peak is fed to a separate inlet provided; the clamped non-composite signal and the sync signal are then added internally in the correct proportions and a composite output is obtained.

Principle of Operation

A shunt clamp is basically a two-terminal device which can be connected across a video signal transmission circuit to re-establish the d.c. and low-frequency components of the signal at the point of connection. A brief description of the principle of operation follows*.

A video signal which has suffered distortion in transmission through a linear system owing to the partial or complete loss of some components (including the d.c. component), or owing to the addition of an interference signal, may be regarded as consisting of the original signal with an added error signal. If the losses or interference occur at frequencies well below line frequency, as in such examples as field tilt or power-frequency hum, the waveform (and d.c. voltage) of the effective error signal can be derived approximately by sampling the video signal during line blanking periods and integrating the pulses obtained.

---

*For further information see:
DOBA, S. and RIEKE, J. W. Clampers in video transmission. *Transactions of the A.I.E.E.*, vol. 69. 1950. pp. 477 to 487. Available as Technical Publications Section reprint article A.37.
SAVAGE, D. C. Three types of television signal stabilizing amplifier. *Television Engineering* (*I.E.E. Conference Report Series No. 5*). 1963. pp. 251 to 258.

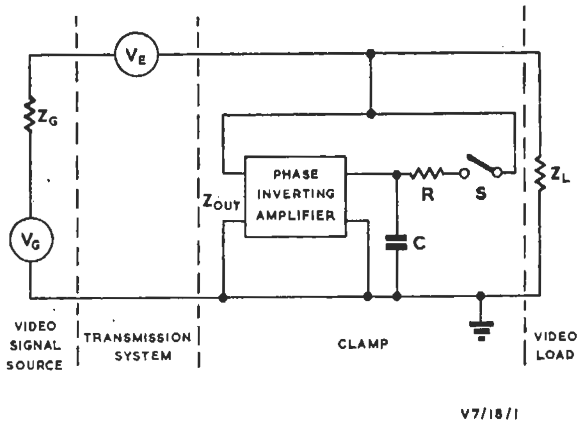


Fig. 18.1. Basic Shunt Clamp

In the basic shunt clamp illustrated in Fig. 18.1, the video signal is sampled by the switch S. The error pulses so obtained are integrated by *R* and *C*, and the signal derived is phase-inverted in an amplifier that has a high current gain and is fed back to the transmission circuit. Fig. 18.2 shows the equivalent circuit for error signals of much less than half line frequency. The input impedance of the clamp, Z_{IN}, is large compared with the impedance of the load, Z_L. The gain of the clamp amplifier is made such that an error signal across Z_L (and Z_{IN}) causes a much larger current to flow in Z_{OUT} than in Z_L, and the clamp acts as if it is almost a short-circuit to the error signal. Consequently, nearly all the error-signal voltage, V_E, is developed across the source internal impedance, Z_G.

Except to the error-signal component, the clamp is made to present a relatively high shunt impedance to the video signal. However, because in practice this impedance cannot be made infinite, in order to prevent mismatch effects it is usually necessary to build the clamp into the shunt arm of a T-network with a characteristic impedance equal to that of the transmission circuit; low-value resistors form the series arms. The clamp then introduces a small insertion loss in the transmission circuit.

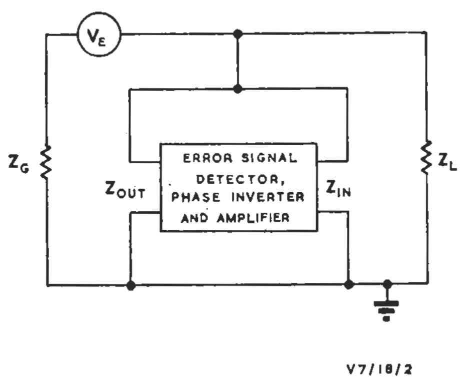


Fig. 18.2. Equivalent Circuit Presented by a Shunt Clamp to Low-frequency Error Signals

The waveform of error signals in excess of half line frequency cannot be reproduced faithfully by the sampling process and the clamp may increase, rather than reduce, the effects of such signals on the video waveform. Random noise is a particular form of error signal that contains higher frequency components, and clamps can worsen the effects of noise on a video signal by producing streaking when the signal is displayed on a picture monitor. To permit control of this deterioration introduced by

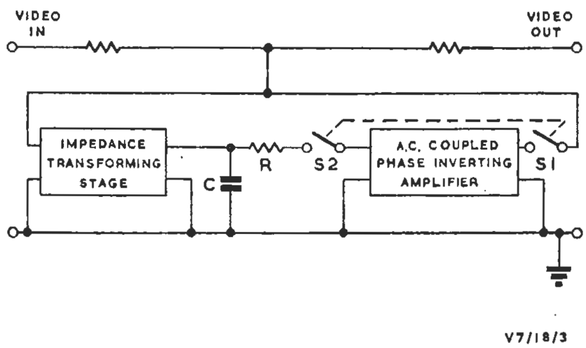


Fig. 18.3. Shunt Clamp with Modified Circuit Arrangement as Used in AM18/509

the clamp, the frequency response of the error-signal feedback is made adjustable by variation of the time constant of the integrating circuit (*R* and *C* in Fig. 18.1). The time constant can then be set to provide the best compromise between the effectiveness of the clamping and the degree of degradation arising from noise or other high-frequency interference. The interference reduction produced by the AM18/509 (and its variants) at different interference frequencies, using the three time constants provided, is shown by Fig. 18.5.

It will be seen that for re-insertion of the d.c. component in the video waveform the amplifier of Fig. 18.1 must be d.c. coupled. However, because high-gain d.c.-coupled amplifiers present certain stability problems, the circuit arrangement shown in Fig. 18.3 is used in the AM18/509. S1 and S2 are synchronous switches, closing during the back-porch period. S1 delivers pulses, varying in amplitude in accordance with the error signal, to the a.c.-coupled amplifier. The pulses are amplified and phase-inverted, and then synchronously demodulated by S2, with the result that the required error-correction signal is developed across *C*, the integrating capacitor. In this way, most of the gain is provided by a.c.-coupled stages.

Circuit Description

General

The block diagram in Fig. 18.4 shows the inter-stage connections of the AM18/509 and indicates the division of the stages between the AM18/508, AM3/501 and GE2/502 sub-units. This diagram applies equally to the single or double groups of the same three sub-units in the AM18/509A to AM18/

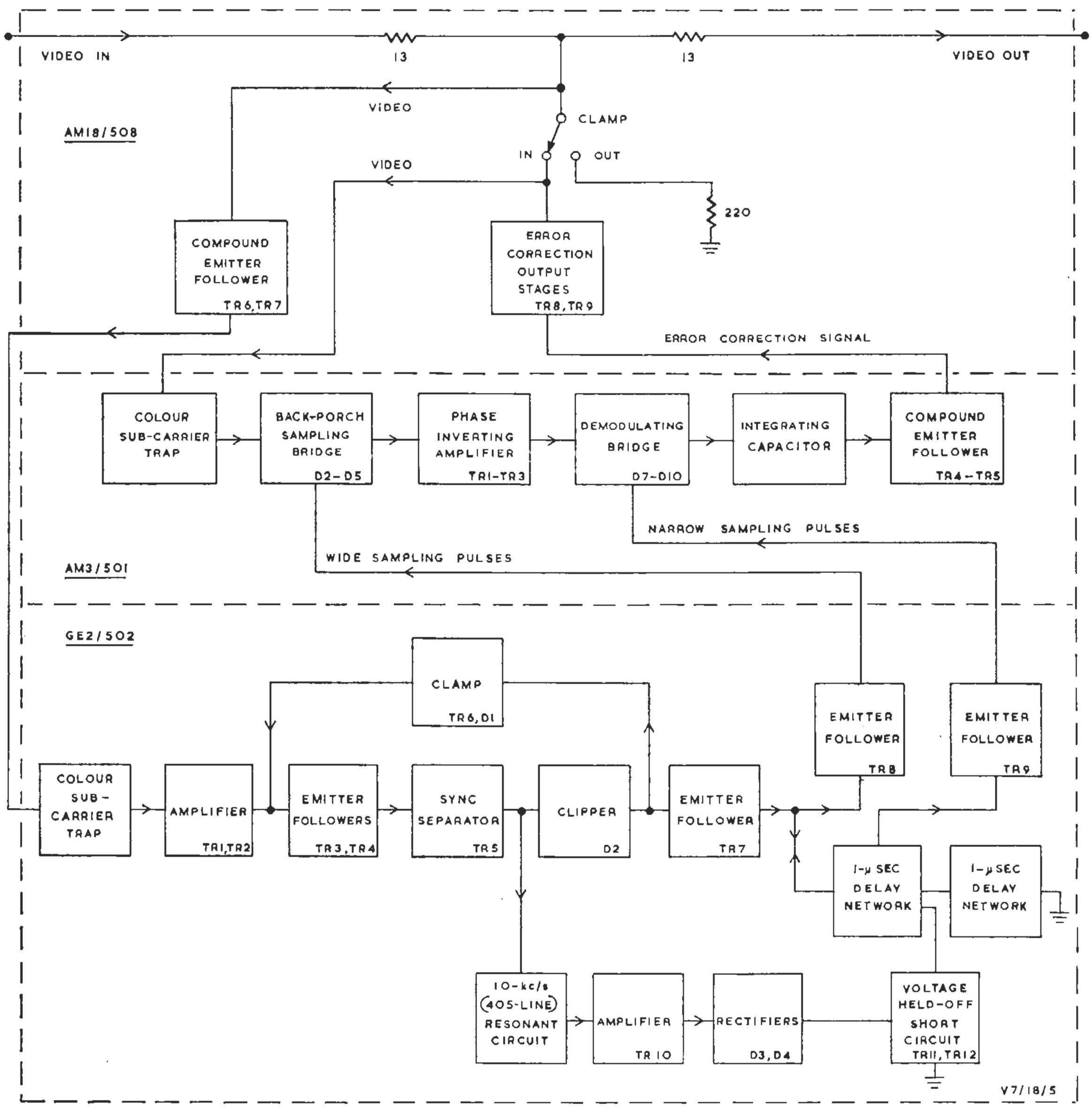


Fig. 18.4. AM18/509: Block Diagram

509D. In each instance the interconnections between the sub-units are as given in detail in Fig. 11, which particularly shows the circuit of the AM18/509D with its two groups of the three sub-units and the relay-controlled output switching. The circuits of the AM18/508, AM3/501 and GE2/502 sub-units are shown fully in Figs. 12, 13 and 14 respectively.

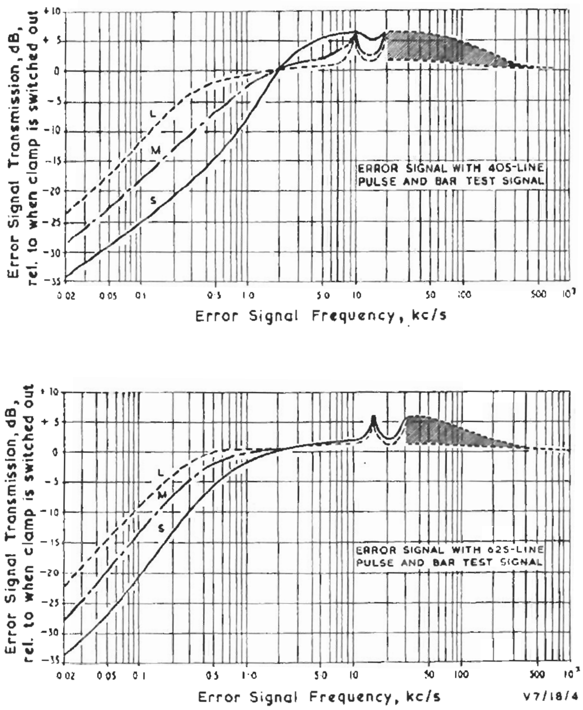


Fig. 18.5. Typical Error-signal Reduction by AM18/509 Switched to Long (L), Medium (M) and Short (S) Time Constant

Drawing No. DSKA 7046

The composite video signal under transmission enters and leaves the AM18/508 sub-unit. In this, the signal passes through a T-network consisting of two series 13-ohm resistors and a shunt arm which primarily comprises either the input and output circuits of the error-signal feedback system or, if this system is switched out of use, a 220-ohm resistor.

When a video signal is being clamped, the voltage of the signal at the junction of the 13-ohm resistors is sampled in back-porch periods by a bridge circuit in the AM3/501 that switches the signal through to a phase-inverting pulse amplifier. The output of this amplifier is synchronously applied by a second, demodulating, bridge to an integrating capacitor. A d.c. or l.f. voltage corresponding, with phase inversion, to the deviation of the back-porch voltage from its correct value develops across the integrating capacitor. This signal is passed back, through emitter-followers, to the error-correction output stage shunting the junction of the 13-ohm resistors in the AM18/508.

The switching action of the bridges in the AM3/501 is produced by pulses that are generated in the GE2/502 from the sync pulses in the video signal. The video signal is applied, via a compound emitter-follower in the AM18/508, to an amplifier in the GE2/502, and is then clamped and passed by emitter-followers to a sync separator. The sync pulses are clipped and fed to two delay networks in tandem. Reflections from the short-circuit terminating the second delay network convert each sync pulse into two successive 4-μsec pulses of opposite polarity whose leading edges coincide with the leading and trailing edges of the sync pulse. This pair of pulses is applied to the AM3/501, where a diode eliminates the first pulse of the pair, leaving the second to make the sampling bridge conduct. Pairs of narrower pulses are tapped from the first delay network, and the second of each pair operates the demodulating bridge in the AM3/501. A 10-kc/s resonant circuit, rectifiers, and two d.c.-coupled transistors are arranged to withhold a short-circuit from the first delay network while a 405-line signal is being clamped, but otherwise allow it to be imposed automatically, so that the generated pulses are shorter and lie within the back-porch periods employed in other line standards.

In the AM18/509E, the sub-units Type AM18/508, AM3/501 and GE2/502 are, in most respects, interconnected as shown in Fig. 11 and function as described previously. However, the GE2/502 obtains its input via the additional UN3/507 sub-unit, and the clamped signal from the AM18/508 passes through the UN3/507 and the AM5/507, the other additional sub-unit, before becoming the output of the equipment. The circuit of the UN3/507 is shown in Fig. 15 and the circuit of the AM5/507 (described in Section 5 of this Instruction) is shown in Fig. 7. The input to the GE2/502, obtained via the UN3/507, can be either a composite signal provided from the AM18/508 as in the other variants of the AM18/509, or it can be a mixed sync signal applied from an external source. Correspondingly, a composite video signal can be clamped in the AM18/508 sub-unit and passed through the UN3/507 to the AM5/507, or a signal without sync pulses can be clamped in the AM18/508 while sync pulses from an external source are both fed to the GE2/502 and are added to the clamped signal as it passes through the UN3/507.

Video Signal Transmission (*AM18/508: Fig. 12*)

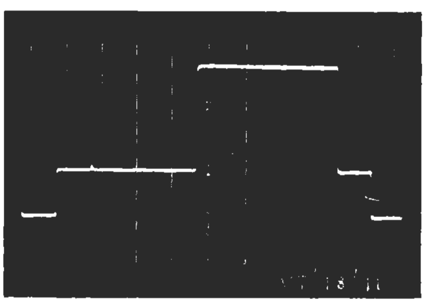
The incoming video signal (which may be non-composite in the AM18/509E) is applied from the input coaxial plug of the equipment to pin 14 on the multi-pole plug of the AM18/508 sub-unit. From here it passes through R16 and R17, each 13 ohms, and then out of the AM18/508 via pin 13 of the multi-pole plug. The junction of R16 and R17 is connected to the two-position switch SB, which is provided for switching the clamping action of the equipment in or out of use. When the switch is set to the *In* position, the junction of R16 and R17 is joined to the input and output circuits of the error-signal feedback system. To the true video signal this point presents a shunt resistance of approximately 220 ohms (with compensation provided by L1 and R36 to reduce the effects of stray shunt capacitance at high video frequencies), but to any spurious low-frequency error component the impedance is very much lower. If the switch is moved to the *Out* position, the junction of R16 and R17 is shunted to earth by the 220-ohm resistor R20. This arrangement ensures that, whether or not the error-signal feedback is switched into use, with respect to the required components of the video signal the AM18/508 presents the same input and output impedances and introduces the same loss in transmission, namely 75 ohms and 3 dB.

From the AM18/508 sub-unit, the video signal passes to the output coaxial socket of the equipment directly, except in the AM18/509D or AM18/509E, in which it first passes through the switching or gain control and amplifier circuits (described later).

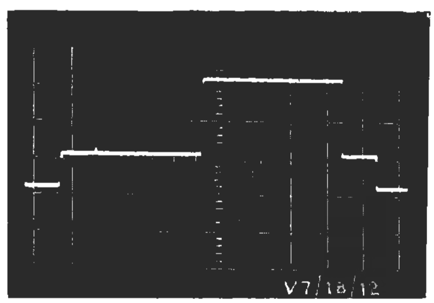
The monitoring points M1 and M2 are provided for checking the video signals entering and leaving the AM18/508 sub-unit. Resistors R14 and R18 are fitted in series with M1 and M2 respectively to ensure that the video transmission circuit is not appreciably affected by apparatus connected for monitoring. At either point, monitoring should be carried out by means of a low-capacitance oscilloscope probe to obtain a good reproduction of the waveform. Waveform 1 shows a pulse and bar input to the equipment as monitored at M1, and Waveform 2 shows it reproduced, with 3-dB loss, as monitored at M2.

A mains-frequency interference signal can be imposed on the video signal input by operation of the *Test* push-button switch SA. This enables the clamping action of the equipment to be checked. The interference test signal is derived from the mains transformer winding supplying the pilot lamp and is applied to the video input circuit via SB and R15. The value of R15 is such that, when the equipment is connected in a 75-ohm transmission circuit but the *Clamp* switch is set to *Out*, a mains-

Waveforms on the AM18/508 Sub-unit
with a 405-line Pulse and Bar Signal Applied



Waveform 1: M1
Vertical scale: 0·25 V per square
Horizontal scale: 10 μsec per square



Waveform 2: M2
Vertical scale: 0·25 V per square
Horizontal scale: 10 μsec per square

frequency signal of about 0·7 volt peak-to-peak is injected in the video signal path.

Back-porch Sampling (AM3/501: Fig. 13)

The video signal developing at the junction of R16 and R17 in the AM18/508 sub-unit is fed into the AM3/501 via pin 8 on its multi-pole plug. Providing that the internal switch S1 is set to its central position (the position for normal operation) the signal passes through R1, S1 and R4 to the sampling bridge consisting of RV1 and diodes D2 to D5. The input signal can be examined at the junction of S1 and R4 by use of the monitoring point M1 (Waveform 3).

Between R4 and the bridge, C1 and L1 in series form a circuit to earth which can be resonated at the frequency of the colour sub-carrier component, if any, in the video signal; if the tap on L1 is used, the core of L1 can be set so that the frequency of resonance is 4·43 Mc/s, or if L1 is fully used, the frequency of resonance can be made 2·66 Mc/s. With R1 and R4, and R35 in the AM18/508, the low impedance of C1 and L1 at resonance forms a potential divider which reduces the colour sub-carrier burst to a negligible level and so prevents it from constituting a spurious error signal.

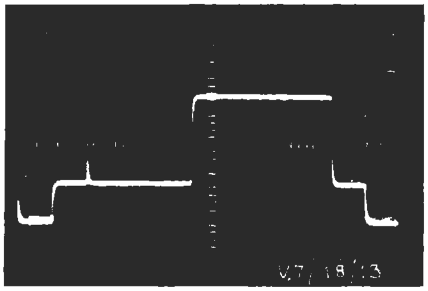
The sampling bridge is driven by the wide sampling pulses which are supplied from the GE2/502. These pulses are fed to the bridge through C3, the step-up transformer T1, and C2 and C4. Whereas the waveform of the driving signal generated by the GE2/502 consists of a recurring pair of pulses, one positive and one negative (Waveform 12), diode D1 is so connected across the secondary winding of T1 that it short-circuits the first pulse of each pair. (As a result, the first pulse is largely eliminated in the output of the loaded GE2/502, as shown in Waveform 14.) This leaves only the pulse of opposite polarity, which occupies time within the back-porch period. Each remaining pulse applied through C2 and C4 (Waveforms 4 and 5) causes the bridge diodes, D2 to D5, to conduct. When these diodes conduct, C2 and C4 charge to a voltage nearly equal in total to the peak value of the driving pulse. At the end of the pulse the two charged capacitors, connected in series by the secondary of T1, apply a reverse potential of about 8 volts to the bridge, rendering it non-conducting. Although C2 and C4 discharge through R5, the time constant is long compared with a line period, and the reverse voltage persists until the next sampling pulse, by which time the reverse voltage has dropped sufficiently to allow the diodes to conduct again.

While the bridge conducts, during each back-porch period, it acts as a closed switch conveying the voltage level of the back-porch from R4 to C5. The side of C5 which is connected to the bridge is also continuously fed, via R6, from RV2 in the network consisting of RV2, R7, R8, R9 and R32. This is a d.c. potential dividing network symmetrically connected between the supplies of +4 volts and −4 volts, and by means of RV2 the d.c. voltage continuously applied through R6 to C5 can be adjusted to be zero, or to be positive or negative with respect to earth over a small range. If the voltage received via the bridge during the back-porch periods differs from the voltage set by RV2, pulses having a polarity and amplitude corresponding to the difference develop across R6 and are fed by C5 to the transistor TR1; this is the error signal. Normally, RV2 is set so that when the back-porch does not differ from earth potential no pulses develop.

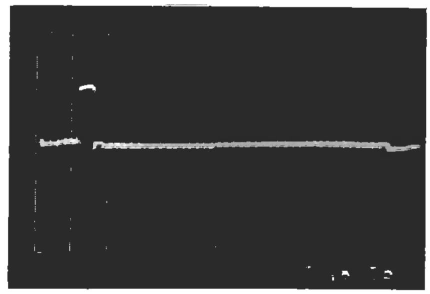
When the bridge conducts, C5 receives not only the back-porch voltage from R4, but also any difference in voltage developing across the bridge, effectively in series between R4 and C5, due to inequality in the small voltage drops across the conducting diodes. Such a difference in voltage across the bridge can be balanced out by adjustment of the slider of RV1. This operation determines the proportions in which the resistance of RV1 is divided between the bridge arms containing diodes D3 and D4. Transients appearing at the bridge centre points as the bridge goes in and out of conduction are reduced by adjustment of the differential trimmer C18. In practice, RV2, RV1 and C18 are set to provide satisfactory clamping of the back porch, and a uniform blanking level in line and field blanking periods, without spurious pulses in the back porch.

Whereas the central position of switch S1 is the normal setting, at which the video signal from the AM18/508 is taken into the AM3/501, the other two positions of the switch are for test purposes. At these positions the input from the AM18/508 is disconnected, and thus the error correction feed-back loop is open-circuited, while 0 volts or −10 mV d.c. are applied to the AM3/501. By setting S1 to feed 0 volts and −10 mV to the sampling bridge, back porches at earth and at a standard deviation from earth are simulated respectively. The switch is mounted inside the AM3/501 sub-unit and the operating bar attached to the shaft of the switch must be positioned horizontally, setting the switch to the central (normal)

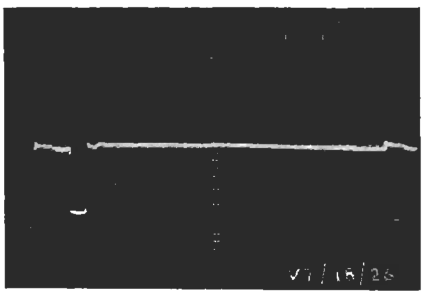
Waveforms on the AM3/501 Sub-unit with a 405-line Pulse and Bar Signal Applied



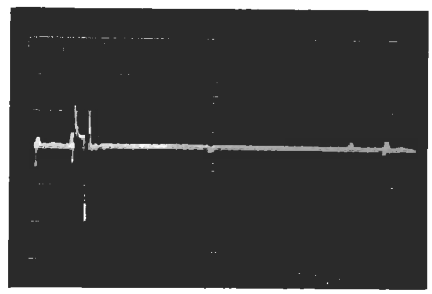
Waveform 3: M1
Vertical scale: 0·25 V per square
Horizontal scale: 10 µsec per square



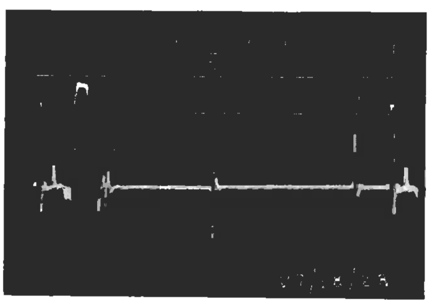
Waveform 4: C2
Vertical scale: 2·5 V per square
Horizontal scale: 10 µsec per square



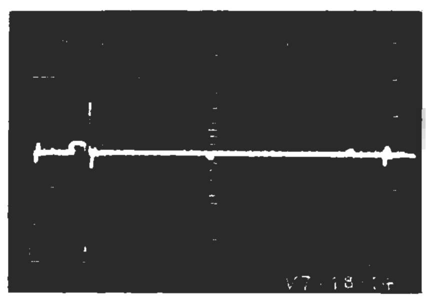
Waveform 5: C4
Vertical scale: 2·5 V per square
Horizontal scale: 10 µsec per square



Waveform 6: TR1 Collector
Vertical scale: 0·25 V per square
Horizontal scale: 10 µsec per square



Waveform 7: Terminal 4 on T2
Vertical scale: 0·25 V per square
Horizontal scale: 10 µsec per square



Waveform 8: M2
Vertical scale: 2·5 V per square
Horizontal scale: 10 µsec per square

position, before the AM3/501 can be inserted in the framework of the equipment. The other two positions of the switch can be used if the AM3/501 is operated out of the equipment on extension connections.

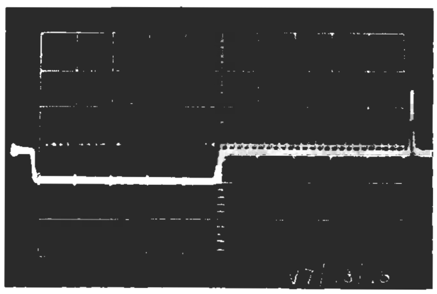
Phase-inverting Pulse Amplifier (*AM3/501: Fig. 13*)

The error pulses, if any, passed by the sampling bridge and developing across R6, are amplified by TR1. This transistor is in a common-emitter circuit providing a voltage gain of about twenty times. The pulses are applied from the collector of TR1 (Waveform 6), via C9, to the compound emitter-follower consisting of TR2 and TR3. The pulse output from the emitter of TR3 is fed, via C10, to the transformer T2. This gives a further voltage step-up of ten times, making a total of about 46 dB voltage amplification to the secondary terminals of T2.

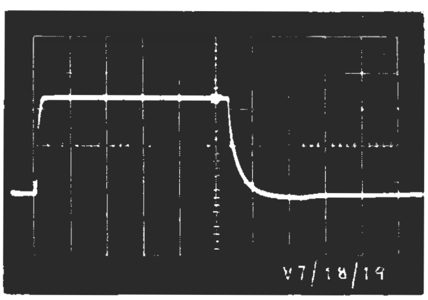
Only one signal inversion occurs in the amplification of the error pulses, i.e., that taking place in TR1. Consequently, the output of T2 consists of amplified error pulses of opposite polarity to those obtained from the sampling bridge, whatever their polarity may be.

The pulse signal taken from the junction of C10

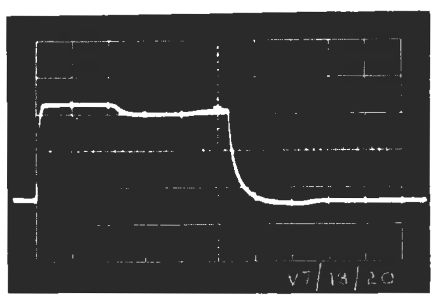
Waveforms on the GE2/502 Sub-unit with a 405-line Pulse and Bar Signal Applied



Waveform 9: M1
Vertical scale: 0·25 V per square
Horizontal scale: 2 μsec per square



Waveform 10: TR7 Base
Vertical scale: 2·5 V per square
Horizontal scale: 2 μsec per square



Waveform 11: TR7 Emitter
Vertical scale: 2·5 V per square
Horizontal scale: 2 μsec per square

and T2 to pin 4 on the multi-pole plug of the AM3/501 is not normally used in the stabilising amplifier AM18/509 or its variants.

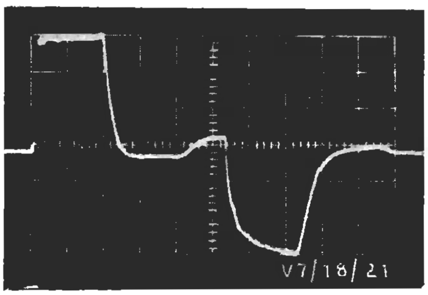
Error Pulse Demodulation (*AM3/501: Fig. 13*)

The amplified and inverted error pulses are applied from the secondary winding of T2 (Waveform 7), via C11, to the demodulating bridge consisting of diodes D7 to D10. The input to the bridge can be monitored at M2 (Waveform 8).

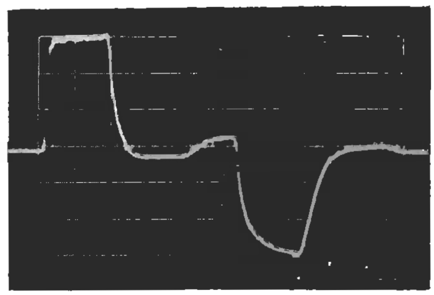
The demodulating bridge is driven by the narrow sampling pulses supplied by the GE2/502. As with the wide sampling pulses, the GE2/502 generates pairs of pulses (one pulse of each polarity), but the first pulse in each pair is eliminated, in this instance by D6, leaving each second pulse to drive the bridge (Waveform 15). These pulses are synchronous with the wide sampling pulses driving the back-porch sampling bridge but, as described elsewhere, the narrow sampling pulses are so generated that their leading edges occur 0·2 μsec later and their trailing edges occur 0·2 μsec earlier.

The demodulating bridge functions in the same manner as the back-porch sampling bridge, which has been fully described earlier. Accordingly, it can be regarded as a switch passing the output of

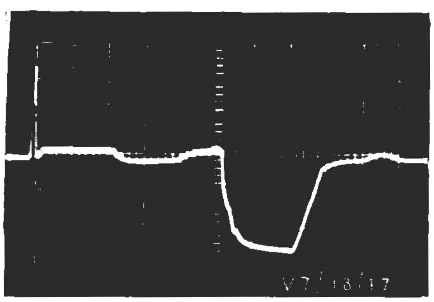
Waveforms on the GE2/502 Sub-unit
with a 405-line Pulse and Bar Signal Applied



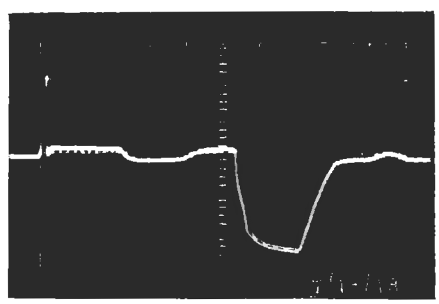
Waveform 12: M2 (GE2/502 unloaded)
Vertical scale: 1 V per square
Horizontal scale: 2 μsec per square



Waveform 13: M3 (GE2/502 unloaded)
Vertical scale: 1 V per square
Horizontal scale: 2 μsec per square



Waveform 14: M2 (output to AM3/501)
Vertical scale: 1 V per square
Horizontal scale: 2 μsec per square



Waveform 15: M3 (output to AM3/501)
Vertical scale: 1 V per square
Horizontal scale: 2 μsec per square

T2 while each error pulse is fully developed, but presenting a high impedance for the rest of the time, including the time in which the leading and trailing edges of the error pulses occur. The demodulating bridge does not require a balancing potential divider, corresponding to RV1 in the back-porch sampling bridge, because in this instance the bridge output is not amplified and the small degree of unbalance which may exist can be neglected.

When the demodulating bridge conducts, it links the secondary of T2, via C11, to the integrating capacitor comprising C15 and C16 in parallel. One of the resistors R20, R22 or R23 is connected in series with the secondary of T2 by means of the switch S2. During a period of conduction by the bridge, C15 and C16 tend to charge, or discharge through the resistor and C11, to the peak voltage of the pulse reproduced by T2, which is an amplified and inverted representation of the deviation of the video signal back porch from earth potential. Variations in the back-porch voltage cause the voltage across C15 and C16 to alter in steps coincident with the error pulses. The time constant of the charging or discharging of C15 and C16 depends on the resistor selected by means of S2 and determines how closely the envelope of the error pulses is followed by the signal formed by the voltage on C15 and C16. Thus, the amplitude of the a.c. signal developing on C15 and C16 is a function of the amplifier gain and of the time constant of the integrating circuit. As an example, the amplification of a 50-c/s variation of the back porches when reproduced on C15 and C16 is about 38 dB if R23 is in use (S2 switched to *Short Time Constant*) and about 26 dB if R20 is in use (S2 switched to *Long Time Constant*). A continuous error in the back-porch voltage gives rise to a steady voltage across C15 and C16 whose magnitude depends only on the gain of the amplifier, which as stated is about 46 dB.

The voltage developed on C15 and C16 is the error-correction signal to be fed back to the final stage shunting the video signal transmission circuit. The error correction signal is applied from C15 and C16 to the base of TR4. Transistors TR4 and TR5 form a compound emitter-follower which presents a high input impedance resulting in negligible discharge of C15 and C16 during a line period, and also provides a low output impedance for driving the final error-correction circuits in the AM18/508 sub-unit. In the absence of any amplified and inverted error pulses, the d.c. voltage developing on C15 and C16, and therefore on the base of TR4, is determined by the setting of RV3; the d.c. voltage at the movable contact on RV3 is applied continuously through R24 to the input side of the demodulating bridge and therefore RV3 forms a standing d.c. source feeding C15 and C16 each time the bridge conducts. Because TR4 is d.c.-coupled, through TR5, to the final error-correction circuits in the AM18/508, control RV3 provides a means of adjusting the d.c. working conditions of these stages and the d.c. voltage they may tend to introduce on the video signal transmission circuit.

The thermistor TH1 and the transistors TR6 and TR7, joined to the fourth contact on S2, are for automatic time-constant control. This is a feature not used in the AM18/509 or its variants. Accordingly, pins 10 and 11 on the multi-pole plug of the AM3/501 do not make any connection to circuits outside the sub-unit in these equipments.

Error-correction Output Stages (AM18/508: Fig. 12)

The error-correction signal from the AM3/501 enters the AM18/508 sub-unit via pin 6 on its multi-pole plug. The signal is applied to the base of the npn transistor TR8 through the Zener diode MR11 and R28. The complete signal is shifted negatively about 9 volts by being passed through MR11 in order to meet the operating requirements of TR8. Any higher frequency components in the error-correction signal that might cause distortion of the video signal back porches are reduced by the smoothing circuit formed by R28 and the shunt capacitor C9.

Transistor TR8 is in an emitter-follower circuit driving the common-base stage containing the npn transistor TR9. The base of TR9 is held at a negative voltage by the fixed potential divider consisting of R33 and R34, decoupled by C10. If the *Clamp* switch SB is set to *In*, the collector of TR9 is connected via L1 and R36 to the junction of R16 and R17 in the video transmission path, and TR9 tends to form a short-circuit to the error component in the video signal by passing current under the influence of the error-correction signal applied to its emitter.

Sync Pulse Separation (AM18/508 and GE2/502: Figs. 12 and 14)

In the AM18/508 sub-unit, the video signal voltage at the junction of R16 and R17 is applied via C8 to the compound emitter-follower consisting of TR6 and TR7. The full video waveform, slightly attenuated in amplitude, is reproduced at the emitter of TR7, from which the signal is passed to the GE2/502 (through the UN3/507, if switched appropriately, in the AM18/509E).

The video signal enters the GE2/502 via pin 8 on its multi-pole plug. Waveform 9 shows the sync pulse in an input signal as observed by using monitoring point M1. (Only the region about the sync pulse and back porch is shown in this and the majority of the illustrated waveforms of the GE2/502 because the action of the sub-unit is primarily on this part of the signal). The video signal is applied to transistor TR1 through the colour sub-carrier trap circuit consisting of L1 and C2 in parallel; depending on whether the tap on L1 is used or all of L1 is employed, the core of L1 can be set so that the circuit presents a high impedance at 4·43 Mc/s or 2·66 Mc/s.

TR1 and TR2 form an amplifier with negative feedback. TR1 is in a common-base circuit which is directly coupled to the emitter-follower employing TR2. Feedback results from the connection of TR1 base to the junction of R3 and R4, which serve as the emitter load of TR2.

The video signal output from the emitter of TR2 is coupled by C4 to the base of the emitter-follower TR3. The video signal waveform is clamped at the base of TR3 by the action of C4 and the diode D1, which conducts due to positive-going sync pulses returned by the npn transistor TR6 from a further point in the signal path. The emitter of TR3 is connected via R8 to the base of TR4, another emitter-follower. TR4 provides a low-impedance source driving the sync separator TR5 through C6. Capacitor C6 is charged by the base current drawn by TR5 during each negative-going sync pulse and TR5 is then cut off while the remainder of the applied video waveform is more positive. A small discharge through R12 allows the flow of base current to be repeated in each sync pulse. Thus, only the sync pulses in the video signal cause TR5 to conduct, and from these TR5 produces positive-going pulses at its collector. The network consisting of R8, C5 and R9, between TR3 and TR4, modifies the low-frequency content of the video signal to neutralise sag and ensure continuous operation of the sync separator over the period of the field sync signal.

The separated sync pulses, which have an amplitude of about +11 volts at the collector of TR5, are fed through R14 to the clipper diode D2. In conjunction with R14, D2 clips the pulses to an amplitude of +7 volts. Because stray capacitance at the output end of R14 would cause the loss of high-frequency components, R14 is shunted by C7 to retain a good pulse shape. The clipped sync pulses are applied both to TR6, which produces the clamping action through D1, and to TR7, which is an emitter-follower feeding the sampling pulse generating circuits (Waveform 10).

Unclipped sync pulses are applied from the collector of TR5, through R21, to the circuit which automatically controls the duration of the sampling pulses generated.

In an AM18/509E, if a non-composite signal is being clamped, a sync signal from an external source is fed via the UN3/507 into the GE2/502 and is, in general, acted upon by TR1 to TR5 as previously described.

Sampling Pulse Generation (*GE2/502: Fig. 14*)

Sync pulses are fed from the emitter-follower TR7 (Waveform 11), through C9 and R18 (510 ohms), to the delay networks DN1 and DN2 in tandem. The delay networks have a characteristic impedance of 500 ohms and each provides a transmission delay of 1 μsec. A short-circuit permanently terminates the second delay network, DN2, but an intervening short-circuit is automatically imposed on DN1, by means described later, if the equipment is not being used on a 405-line video signal.

At the commencement of a sync pulse generated at TR7 emitter, half the pulse amplitude develops at the input terminal of DN1. Providing no intervening short-circuit is imposed, the leading edge of the pulse travels through both delay networks and is reflected in antiphase by the short-circuit terminating DN2. The reflected leading edge appears at the input terminal of DN1 at a time after the initial application of the pulse equal to twice the delay time between the input terminal and the short-circuit, that is, 4 μsec. Resistor R18 matches the delay networks and prevents further reflection of the pulse back into DN1. Because the pulse suffers negligible attenuation in its forward and return transmission, and is reflected in antiphase, it cancels the remainder of the applied positive-going sync pulse at the input terminal of DN1 after 4 μsec. When the applied sync pulse finishes, a negative-going pulse develops at the input terminal of DN1, due to the reflection alone, lasting for the total forward and return delay time, 4 μsec. The result of this action is that each sync pulse at the base of TR7 is converted into two 4-μsec pulses at the input terminal of DN1, one positive and one negative, each of about 3 volts amplitude and occurring in time just after the leading and trailing edges of the sync pulse. The base of the emitter-follower TR8 is connected to the input terminal of DN1 and receives these pulses. The pairs of pulses are reproduced at the emitter of TR8 and form the 'wide sampling pulse' output of the GE2/502 (Waveform 12).

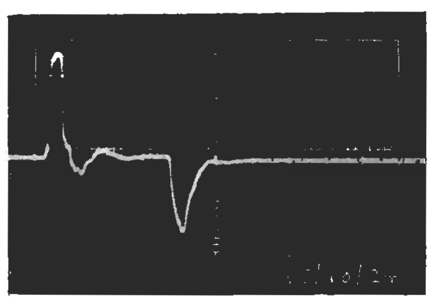
The base of the emitter-follower TR9 is connected to a tap on DN1 that is reached by the leading edge of the incident pulse 0·2 μsec after it leaves the input terminal, and by the reflected leading edge 0·2 μsec before it arrives at the input terminal. The signal at the base of TR9 thus takes the form of pairs of pulses as at the base of TR8, but the pulses are 0·4 μsec shorter; they each have a duration of 3·6 μsec when reflection is from the short-circuit terminating DN2. These pairs of pulses are reproduced at the emitter of TR9 and form the 'narrow sampling pulse' output of the GE2/502 (Waveform 13).

If optimum clamping is to be obtained, the duration of the sampling pulses must be as long as is practicable within the time of the back porch to be sampled. However, whereas the 4-μsec and 3·6-μsec sampling pulses are suitable for 405-line operation, shorter pulses are necessary for other line standards. For this reason, an intervening short-circuit is automatically imposed on the delay networks when the clamped signal is not a 405-line signal, so that the reflection time is reduced and the sampling pulses are shortened accordingly. The automatically imposed short-circuit can be at the output terminal of DN1 or at a point on DN1 corresponding to 0·6 μsec delay, according to the terminal on DN1 to which the automatic circuit is linked; the first arrangement gives 2-μsec sampling pulses at the input terminal of DN1 for 625-line operation, and the second arrangement gives 1·2-μsec sampling pulses for 525-line, 625-line and 819-line operation (Waveform 16). In each instance the pulses derived from the 0·2-μsec delay tap on DN1 and supplied as output via TR9 are 0·4 μsec shorter (Waveform 17).

The intervening short-circuit applied to DN1 is controlled by a circuit taking sync pulses (unclipped) from the collector of the sync separator TR5. The sync pulses are fed from TR5, through R21, to the series tuned circuit consisting of L2 and C10. This is resonant at the line frequency of 405-line signals. When a 405-line signal is being clamped by the equipment, the 10·125-kc/s output of the resonant circuit is amplified by TR10 and then rectified in the voltage-doubler circuit comprising C12, D3, D4 and C13. At the base of the emitter-follower TR11, the negative d.c. voltage resulting from the rectification opposes the standing positive voltage developed by the Zener diode D5 and applied through R26. In these circumstances, the small positive voltage produced at TR11 emitter cuts off the following npn transistor, TR12, which has +4 volts applied to its emitter. However, if the video signal being clamped is not a 405-line signal, the

Waveforms on the GE2/502 Sub-unit with a 625-line Pulse and Bar Signal Applied

Waveform 16: M2 (GE2/502 unloaded)
Vertical scale: 1 V per square
Horizontal scale: 2 μsec per square



Waveform 17: M3 (GE2/502 unloaded)
Vertical scale: 1 V per square
Horizontal scale: 2 μsec per square

output of the 10-kc/s resonant circuit is small, the voltage developed by D5 is not opposed at TR11 base, the voltage produced at TR11 emitter is sufficiently positive to make TR12 conduct, and consequently the emitter of TR12 then presents an effective short-circuit to the point on DN1 to which it is connected.

Power Supplies (AM18/508: Fig. 12)

The AM18/508 sub-unit produces its own power supplies and also provides all the requirements of the associated AM3/501 and GE2/502 sub-units. The AM18/508 contains sources of d.c. at —10, —4 and +4 volts, and two separate sources at +12 volts. All the sources derive their power from the mains transformer T1.

A 20-volt secondary winding on T1 feeds the rectifier bridge consisting of MR1 to MR4. The output of this bridge, passing through R1, is shunt-stabilised by the Zener diodes MR9 and MR12. The supply of d.c. at —10 volts is taken from the junction of R1 and MR9.

The transistor TR4 is in an emitter-follower circuit fed from the negative 10-volt supply. The emitter of TR4 is the source of d.c. at —4 volts, the output from the emitter of TR4 being stabilised at this voltage as a result of the fixed voltage applied to the base of TR4 from the potential divider consisting of R2 and R3.

Another 20-volt secondary on T1 is connected to the second rectifier bridge, MR5 to MR8. Rectified output from this bridge passes through R7 and is series regulated by TR3. The output from the emitter of TR3 is the 'A' supply at +12 volts. TR3 is controlled at its base by the emitter output of TR2. The current through TR2 is determined by the collector output of TR1, which receives a fraction of the supply output voltage at its base while its emitter is held at a reference voltage by the Zener diode MR10.

Some current from the second rectifier bridge, MR5 to MR8, passes through R7 and the series resistors R38 and R39 to the shunt-stabilising diodes MR13 and MR14. The output from the junction of R39 and MR14 is the 'B' supply at +12 volts.

The transistor TR5 is in an emitter-follower circuit fed from the positive 12-volt 'A' supply and functions similarly to TR4. The emitter of TR5 is the source of d.c. at +4 volts.

By strapping R37 in parallel with R1 and by strapping a short-circuit across R39, the negative 10-volt supply circuit and the positive 12-volt 'B' supply circuit can be modified to provide an extra 66 mA and 50 mA respectively in excess of the normal requirements of the stabilising amplifiers AM18/509 to AM18/509E.

In the AM18/509E, one additional sub-unit, the UN3/507, receives current from the 12-volt 'A' supply of the AM18/508, but requires no other d.c. inputs. The other extra sub-unit, the AM5/507, contains its own power supply circuits; see Section 5 and Fig. 7 in this Instruction.

Output Switching in an AM18/509D (Fig. 11)

Although the AM18/509D contains two groups of sub-units (AM18/508, AM3/501 and GE2/502) and has coaxial plugs for accepting separate video signal inputs to these groups, the amplifier has only one video outlet. The output from this consists of one of the signals, clamped by the group to which it is fed and selected from the AM18/508 sub-units by means of the switching system formed by the relays RLA, RLB and RLC, and associated components, on the main chassis.

The relays are energised and controlled via the four-pole plug PLB. A 50-volt d.c. input from an external source is required at PLB; pins 1 and 3 on the plug should be connected to the negative and positive output points of the source respectively. By remotely making or breaking contacts leading to pins 2 and 3 on PLB, one or other of the two clamped video signals is selected as output.

If there is no external path between pins 2 and 3 on PLB, none of the relays is energised. Under these conditions, one set of change-over contacts on RLA and one set on RLC convey, in parallel, the signal from the AM18/508 in the first group of sub-units to the output plug. At the same time, another set of change-over contacts on RLA and another set on RLC both pass the signal obtained from the second AM18/508 to the 75-ohm internal load, R4.

When an external connection is initially made between pins 2 and 3 on PLB, relays RLC and RLB are energised. Change-over switching then occurs on both sets of contacts on RLC. As a result, the signal from the second AM18/508 is fed to the output plug where it adds to the signal still conveyed by RLA from the first AM18/508, and R4 is switched so that it loads the first AM18/508 as well as the second and is therefore in parallel with the output plug. Simultaneously, RLB closes a pair of contacts feeding current to the coil of RLA. Delayed by about 20 msec, the contacts on RLA again make connections in parallel with the contacts on RLC. Then, one set of change-over contacts on RLA shares in feeding the signal from the second AM18/508 to the output plug, while the other set of contacts duplicates the connection between the first AM18/508 and R4.

When the connection between pins 2 and 3 on PLB is broken, a similar sequence occurs and again there is a delay during which the signals from both AM18/508 sub-units are fed to the output plug and also R4; in this instance, the discharge of C1 through the coil of RLA contributes to the delay. Finally, the conditions return to the state first described.

Gain Control and Sync Adding in AM18/509E (UN3/507: Fig. 15)

The video input to an AM18/509E may be *composite* or *non-composite*. The signal is clamped in the AM18/508 sub-unit and enters the UN3/507 via pin 4 on the multi-pole plug. It is attenuated by 3 dB in the network R1 to R3 and by another 6 dB in the mixing network R4 to R6. The signal obtained from the mixing network, developing across R7, is passed through the *Gain* control, RV1, and from the moving contact of RV1 the signal is fed out of the UN3/507 to the AM5/507. According to its setting, RV1 may add up to 6 dB more attenuation. Thus, disregarding the sync pulses if these are added in the network R4 to R6, but including the 3-dB loss in the AM18/508, the signal may be from 12 to 18 dB lower on reaching the AM5/507 than at the input plug of the AM18/509E. Because the AM5/507 has a gain of 15 dB, the overall gain can be adjusted from —3 dB to +3 dB on RV1.

When a *composite* video signal is being clamped, switch SA on the UN3/507 is accordingly set to *Comp.* Under these conditions, the composite signal reproduced by TR7 in the AM18/508 sub-unit enters the UN3/507 via pin 10 on its multi-pole plug and is passed by the switch SA directly out to the GE2/502.

If a *non-composite* video signal is being clamped, SA is set to *Non. Comp.* and a mixed sync signal of 2 volts peak-to-peak is applied from an external source to the plug provided for this input on the AM18/509E. The sync signal enters the UN3/507 via pin 12 and is applied to the splitting network R9 to R11. In following one path, the sync pulses are attenuated by 6 dB in passing through the network R9 to R11 and by a further 15 dB by the potential divider formed by R16 and R17. From the junction of R16 and R17, the sync pulses are passed by C1 and SA to the outlet connector feeding the GE2/502. At the same time, the sync pulses follow another route in which they are attenuated 6 dB by the network R9 to R11 and fall an additional 16 dB in the attenuator R12 to R14. This sync signal then passes through SA and is added to the clamped non-composite signal in the network R4 to R6, where the pulses are attenuated a further 6 dB.

During non-composite clamping, the positive d.c. input entering the UN3/507 via R18 is added to the sync signal fed through C1 in order that the signal driving the GE2/502 shall have a d.c. component simulating that otherwise obtained from TR7 in the AM18/508.

The AM5/507, which amplifies the output from RV1 in the UN3/507, is described in Section 5 of this Instruction.

It should be noted that there is no individual control of the amplitude of the sync pulses when these are derived from a separate external source, but that they are altered in amplitude with the picture signal by the *Gain* control. If the sync pulse input is 2 volts peak-to-peak, sync pulses of 0·3 volt are only obtained in the output when the *Gain* control is set at 0dB. If the *Gain* control is adjusted to a particular setting to obtain the required picture signal amplitude in the output, it may be necessary to vary the sync pulse feed externally to obtain the correct picture/sync signal ratio.

Maintenance

Clamping Action

The clamping action can be checked by depressing the *Test* switch. With the *Clamp* switch at *In* and the *Time Constant* switch at *Short*, the 50-c/s wave added by the *Test* switch to a video signal passed through the equipment should not exceed 30 mV peak-to-peak at the monitoring point M2 on the AM18/508 sub-unit. A video signal without superimposed d.c. should be used for this test.

Pre-set Controls

It is unlikely that any alteration to the pre-set controls will be required during normal operation of the equipment. If a semiconductor has to be changed, however, it may be necessary to readjust the section concerned in accordance with the appropriate setting-up test procedure given later.

Identification of Faulty Sub-unit

If the equipment develops a fault, the first step toward clearing it is to identify the sub-unit in which the fault lies. This task is facilitated by the provision of monitoring point waveform illustrations. When a particular sub-unit is thought to be faulty, it should be operated on a chassis extender CH1A/1, which can be fitted in the normal position of the sub-unit; waveforms and voltages can then be measured and compared with those given as a guide on the relevant circuit diagram.

Checking Error Signal Feedback Path

To check the error signal feedback path, operate the AM3/501 on a chassis extender while a video signal is passed through the equipment, and then proceed as follows. Firstly, open the feedback path and earth its input point by moving switch S1 on the AM3/501 to the *0 V* position (by pressing the operating bar at the end bearing this marking). The chain can then be checked using an oscilloscope with a high-impedance probe. Inspect the pulses at each end of the secondary of T1 relative to earth. If these are satisfactory, examine the waveform at monitoring point M2; the pulses (4, 2, or 1·2 µsec, according to the pulses from T1) at this point should be less than 0·3 volt peak-to-peak. When switch S1 is turned to the *—10 mV* position, the pulses at M2 should increase to about 1 volt peak-to-peak. Examine the pulses driving the second bridge by connecting the oscilloscope to each end of the secondary of T3, in turn, while temporarily earthing M2. Remove the earth connection from M2 and check that there is a steady d.c. potential of about +7 volts at M3 when S1 is in the *—10 mV* position. This should decrease to about +6 volts when the switch is moved to the *0 V* position.

General Specification

Sub-unit AM18/508

Signal input	1 V peak-to-peak composite video.
Signal output	As input, reduced 3 dB.
Input and output impedance to video signals	75 Ω ±5%.
Input and output impedance to l.f. error signals	> 13 Ω.
D.C. outputs available	(a) 35 mA at +12 V with < 2 mV peak-to-peak ripple. (b) 120 mA at +12 V with < 80 mV peak-to-peak ripple. (c) 5 mA at +4 V with < 1 mV peak-to-peak ripple. (d) 15 mA at —4 V with < 70 mV peak-to-peak ripple. (e) 66 mA at —10 V with < 150 mV peak-to-peak ripple.
Maximum ambient temperature	40°C.
Mains input voltage range	200 to 250 V a.c.
Mains input power	15 W on full load.
Weight	5 lb.
Size	Constructed on a CH1/12B chassis.

Sub-unit AM3/501

Signal input	< 2 V peak-to-peak composite video.
Signal output	< 6 V peak-to-peak error correction signal.
Input impedance	> 1·5 kΩ.
Output impedance	< 20 Ω.
D.C. gain	> 36 dB.
Maximum ambient temperature	40°C.
D.C. consumption	40 mA at +12 V. 0·5 mA at +4 V. 10 mA at —4 V. When the automatic time constant circuits are not connected, the currents at +12 V and —4 V are each about 8 mA less. (This applies to the AM18/509 and variants.)
Weight	1 lb.
Size	Constructed on CH1/12A chassis.

Sub-unit GE2/502	
Signal input	0·65 V peak-to-peak composite video.
Signal outputs in 405-line operation	(a) A positive and a negative pulse, each 3 V amplitude and 4 μsec duration, commencing with the leading and trailing edges respectively of each sync pulse. (b) Pulses as in (a) but commencing 0·2 μsec later and ending 0·2 μsec earlier.
Signal outputs in 625-line operation	(a) A positive and a negative pulse, each 2·5 V amplitude and 2 μsec duration, commencing with the leading and trailing edges respectively of each sync pulse. (b) Pulses as in (a) but commencing 0·2 μsec later and ending 0·2 μsec earlier.
Signal outputs on other line standards	The pulse durations in both outputs can be reduced further by internal link alteration for operation on other line standards.
Output impedance	Approximately 10 Ω.
Operation on distorted input signals	Operation should be satisfactory on inputs suffering one or more of the following imperfections: (a) Sync pulse amplitude variations of ±6 dB. (b) 50-c/s interference equal to picture amplitude. (c) L.F. distortion equivalent to that caused by transmission through an *RC* circuit having a time constant of 2·4 msec. (d) Random noise having an r.m.s. level of −40 dB with respect to peak-to-peak amplitude of picture signal, when weighted in accordance with C.C.I.R. recommendations.
Maximum ambient temperature	40°C.
D.C. consumption	72 mA at +12 V. 0·1 mA at +4 V. 7 mA at −4 V.
Weight	1½ lb.
Size	Constructed on CH1/12A chassis.

Sub-unit UN3/507	
Signal inputs	0·7 V peak-to-peak composite video, or 0·5 V peak-to-peak non-composite video and 2 V peak-to-peak mixed sync pulses.
Signal output	0·18 V peak-to-peak composite video.
Weight	1 lb 1 oz.
Size	Constructed on CH1/12A chassis.

Sub-unit AM5/507

See Section 5 in this Instruction.

Complete AM18/509	
Signal input	1 V peak-to-peak composite video.
Signal output	Composite video, 3 dB below input.
Input and output impedance to video signals	75 Ω ±5%.
Input and output impedance to l.f. error signals.	> 13 Ω.
Allowable deviation of input back-porch voltage from earth	±2 V across 75 Ω (i.e. before clamp switched in).
Allowable 50-c/s interference at input	0·7 V peak-to-peak across 75 Ω (i.e. before clamp switched in).
Error signal reduction	See Fig. 18.5.

Allowable variation of input sync pulses	$\pm$6 dB with respect to normal amplitude.
k rating on 625-line 2T pulse and bar signal	$<$ 0·5%.
Picture signal distortion factor	$<$ 1%.
Differential gain	$<$ 1% at 4·43 Mc/s.
Differential phase-shift	$<$ 0·25° at 4·43 Mc/s.
Mains bump	$< \pm$8 mV total signal excursion for a sudden mains input change of $\pm$6%.
Hum produced by stabilising amplifier	Below normal sync pulse amplitude by $>$ 47 dB.
Interference on back porch produced by stabilising amplifier	Below normal sync pulse amplitude by $>$ 39 dB.
Maximum ambient temperature	40°C.
Mains input voltage range	200 to 250 V a.c.
Mains input power	14 W.
Signal connectors	Musa plugs.
Mains connector	Cannon Type EP-4-14S plug.
Weight	13½ lb.
Size	Occupies half width in a PN3/21 panel (5¼ in. high).

Complete AM18/509A

This consists of two sections electrically identical to the AM18/509, and differs from it in the following particulars:

Mains input power	28 W.
Weight	21 lb.
Size	Occupies full width in a PN3/21 panel (5¼ in. high).

Complete AM18/509B

This is electrically identical to the AM18/509 and only differs from it in the following respect:

Size	Occupies half width in a PN3/23 panel (5¼ in. high).

Complete AM18/509C

This consists of two sections electrically identical to the AM18/509, and differs from it in the following particulars:

Mains input power	28 W.
Weight	21 lb.
Size	Occupies full width in a PN3/23 panel (5¼ in. high).

Complete AM18/509D

This consists of two sections electrically identical to the AM18/509, with one output selected by relays. It differs from the AM18/509 in the following particulars:

Mains input power	28 W.
Input to relays	50 V d.c.
Weight	22 lb.
Size	Occupies full width in a PN3/23 panel (5¼ in. high).

Complete AM18/509E

This differs from the AM18/509 in the following particulars:

Signal inputs	1 V peak-to-peak $\pm$3 dB composite video, or 0·7 V peak-to-peak $\pm$3 dB non-composite video and 2 V peak-to-peak mixed sync pulses.
Signal output	1 V peak-to-peak composite video
Input and output impedances to l.f. error signals	The value for the AM18/509 only applies to the input here.

Differential phase-shift.	< 0·4° at 4·43 Mc/s.
Mains input power	21 W.
Weight	16 lb.
Size	Occupies three-quarters of the width in a PN3/23 panel (5¼ in. high).

Setting-up Tests and Adjustments*

Sub-unit AM18/508

Only tests on the power supply circuits of the AM18/508 are given here. Tests on the other circuits in the sub-unit are included in the procedure for testing the complete equipment, given later.

(*a*) *Apparatus Required*

Avometer Model 8.
Oscilloscope.
Hum-free audio pre-amplifier, e.g. Philips Type GM4574.
Variac.
Painton 15-pole socket Type 316128 (to fit an AM18/508 plug), with resistors connected from the earth pins (7, 15 and 3 linked) to the appropriate pins to load the AM18/508 supplies as follows:

+12 volts A, pin 4: 330 ohms, 0·5 watt
+12 volts B, pin 9: 100 ohms, 1·5 watts
+4 volts, pin 11: 820 ohms, 0·25 watt
—4 volts, pin 12: 270 ohms, 0·25 watt
—10 volts, pin 10: 150 ohms, 1 watt

and also with a 1·5 kilohm 0·25-watt resistor between the earth pins and pin 6, and two leads suitable for a mains input connected to pins 1 and 2.

(*b*) *Procedure*

1. Check that R37 is strapped in parallel with R1 and that a short-circuiting connection is strapped in parallel with R39.
2. Fit the 15-pole test socket to the AM18/508.
3. By means of the Variac, apply 250 volts a.c. to the AM18/508 through the two leads on the test socket; the neutral side of the mains source should be connected through to pin 2 on the test socket.
4. On the test socket, measure the voltage of each d.c. supply relative to chassis. In each instance the voltage obtained should be within ±10 per cent of the nominal value.
5. Using the oscilloscope and the high gain amplifier (where necessary), measure the peak-to-peak amplitude of the ripple on each supply. The values obtained on the five supplies should be as follows,
   +12 volts A: less than 2 mV peak-to-peak
   +12 volts B: less than 80 mV peak-to-peak
   +4 volts: less than 1 mV peak-to-peak
   —4 volts: less than 70 mV peak-to-peak
   —10 volts: less than 150 mV peak-to-peak
6. Adjust the Variac to decrease the input to 200 volts a.c. and check that the d.c. supplies have not decreased in voltage by more than the following amounts,
   +12 volts A: not more than 0·2 volt drop
   +12 volts B: not more than 1·0 volt drop
   +4 volts: not more than 0·1 volt drop
   —4 volts: not more than 0·5 volt drop
   —10 volts: not more than 1·0 volt drop

Sub-unit AM3/501

This sub-unit is tested and adjusted by the procedure applying to the complete equipment, given later.

Sub-unit GE2/502

(*a*) *Apparatus Required*

Oscilloscope with high impedance probe, e.g. Tektronix Type 515.
Video oscillator, e.g. Wayne Kerr Type 022B.
Variable attenuator, e.g. S.T.C. Type 74600 Group G (0 to 9 dB).
Sine squared pulse and bar waveform generators for 405-line and 625-line standards.
Apparatus including a video driving stage and power supply circuits for feeding the GE2/502. This may take the form of either (a) a stabilising amplifier AM18/509 or AM18/504 with the AM3/501 sub-unit removed and a chassis extender CH1A/1 fitted in the GE2/502 position, or (b) the test circuit shown in Fig. 18.6, consisting of a Painton 316128 15-pole socket (to fit the GE2/502) to which is connected an emitter-follower stage and a stabilised source of d.c., such as a PS2/10, capable of supplying 80 mA at +12 volts, 5 mA at +4 volts, and 10 mA at —4 volts.

*Based on information given in Designs Department Specifications No. 6.86(62), 6.82(62), 6.81(62), 6.98(64), and 6.87(62).

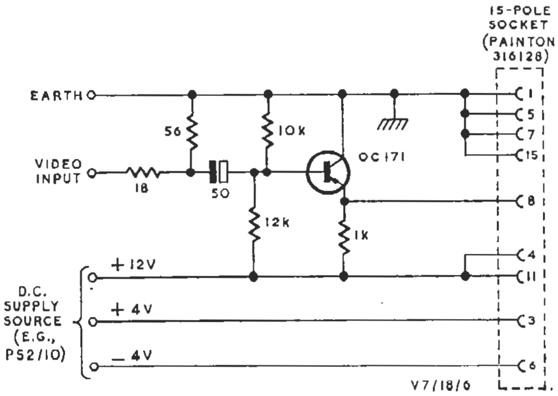


Fig. 18.6. Test Circuit for GE2/502

(*b*) *Procedure*

1. Check that the emitter of TR12 is so connected to the delay network DN1 that the required sampling pulse durations will be obtained in instances when the input to the GE2/502 is not a 405-line signal. See Fig. 14.
2. Check that the connections to L1 are such that L1 can be tuned to provide rejection at the expected colour sub-carrier frequency, if known. The junction of TR1 emitter, R1 and C2 must be connected to the tap on L1 for 4·43-Mc/s rejection, or to the end of L1 for 2·66-Mc/s rejection. See Fig. 14.
3. Fit the GE2/502 to the chassis extender on the AM18/509 or AM18/504, or to the test circuit, whichever is to convey the driving signal and supply d.c. inputs. On an AM18/509 set the *Clamp* switch to *Out* and fit a 75-ohm load to the video outlet. On an AM18/504 set the *Stabilise* switch to *Back Porch*. Switch on the d.c. supplies of the AM18/509, AM18/504, or test circuit.
4. Apply to the signal inlet of the AM18/509, AM18/504, or test circuit, a 0·5-volt peak-to-peak sinc-wave signal at the frequency to which the colour sub-carrier rejection circuit must be tuned. Connect the probe of the oscilloscope to the emitter of TR1. Adjust the core of L1 for minimum amplitude of display on the oscilloscope.
5. Replace the sine-wave input by a 405-line pulse and bar signal (1 volt peak-to-peak), having first ensured that the line frequency is correct. Connect the oscilloscope probe to the base of TR10 and adjust L2 for maximum amplitude of display; the line-frequency signal at this point should not be less than 1·6 volts peak-to-peak. (If necessary, C10 should be changed to permit resonance.)
6. Connect the oscilloscope probe to the monitoring points M2 and M3 in turn and check that the pulses displayed conform with Waveforms 12 and 13 respectively. No pulse should be less than 2·5 volts in amplitude. By means of the attenuator, reduce the input signal 6 dB and confirm that there is no appreciable change in the output pulses.
7. Replace the 405-line input by a 625-line pulse and bar signal (1 volt peak-to-peak). Repeat operation 6, but check that the pulses displayed conform with Waveforms 16 and 17. No pulse should be less than 2 volts in amplitude.

Sub-unit UN3/507

This is used only in the AM18/509E.

(*a*) *Apparatus Required*

Wheatstone bridge.

(*b*) *Procedure*

1. Turn the *Gain* control to +3 *dB* and set the *Video Input* switch to *Comp.* Measure the resistance between pin 4 on the multi-pole plug of the sub-unit and chassis. This should be 75 ohms ±2 per cent.
2. Connect a resistor having a value of 75 ohms ±1 per cent from pin 4 to chassis and measure the resistance between pin 6 and chassis. This should be 37·5 ohms ±5 per cent.
3. Turn the *Video Input* switch to the *Non Comp* position and measure the resistance from pin 12 to chassis. This should be 75 ohms ±2 per cent.

Sub-unit AM5/507

The AM18/509E is the only variant of the AM18/509 using this amplifier. The test procedure for it is given in Section 5 of this Instruction.

Complete AM18/509

It is here assumed that the constituent sub-units have been tested and adjusted as previously described.

(*a*) *Apparatus Required*

Chassis extender CH1A/1.

Wide-band oscilloscope with high-impedance probe, e.g. Tektronix Type 515 or 545.

Video oscillator, e.g. Wayne Kerr Type 022B.

Source of 405-line sync pulses (including field sync pulses) giving a 0·3-volt peak-to-peak signal when loaded with 75 ohms and having no superimposed d.c.

Hum-free audio pre-amplifier, e.g. Philips Type GM4574.

12-dB attenuator, 75 ohms.

625-line sine squared pulse and bar generator.

(*b*) *Procedure*

1. On the AM18/508 sub-unit, if there are straps connecting R37 in parallel with R1 and short-circuiting R39, remove these straps. (The straps are installed for fully loading and testing the AM18/508 sub-unit but they are not required in an AM18/509.)
2. Remove the AM3/501 sub-unit and remount it projecting from its normal position on the chassis extender.
3. On the AM3/501, set the *Time Constant* switch, S2, to *Short* and check that the internal switch, S1, is at its central position (i.e. the *Normal* position with neither end of the operating bar depressed).
4. Ensure that the connections to L1 on the AM3/501 are such that L1 can be tuned to provide, with C1, a low impedance path to earth at the expected colour sub-carrier frequency, if known. The capacitor C1 must be connected to the tap on L1 for series resonance at 4·43 Mc/s, or to the end of L1 for resonance at 2·66 Mc/s. See Fig. 13.
5. Apply to the monitoring point M1 on the AM3/501 a sine-wave signal of 1 volt peak-to-peak amplitude at the frequency to which the colour sub-carrier trap circuit must be tuned. Connect the probe of the oscilloscope to the junction of R4 with C1 and adjust the core of L1 for minimum amplitude of signal displayed on the oscilloscope. Disconnect the applied signal and remove the probe.
6. On the AM3/501, set RV1, RV3 and C18 to the middle of their ranges of movement and turn the switch S1 to the *0 V* position (by pressing the operating bar at the end bearing this marking).
7. Fit a 75-ohm load to the video output plug of the AM18/509. Feed a mains supply to the equipment. Set the *Clamp* switch, SB on the AM18/508 sub-unit, to the *In* position.
8. Feed a 405-line mixed sync signal developing 0·3 volt peak-to-peak (when applied) to the video input plug of the AM18/509. Check that a sync signal having a peak-to-peak amplitude of 0·17 volt ± 10 per cent appears at M1 on the GE2/502.
9. Connect the oscilloscope to M2 on the AM3/501. A train of 4-μsec pulses should be seen. Adjust RV2 on this sub-unit to reduce the pulses to zero.
10. On the AM3/501, turn S1 to the *—10 mV* position (by pressing the bar at the end bearing this marking). Positive-going 4-μsec pulses of at least 1 volt peak-to-peak should be obtained on the oscilloscope connected to M2. If not, check that the amplitude and polarity of the pulses driving the sampling bridge (D2 to D5) are satisfactory and check the gain of the stage containing TR1. The voltage gain of the TR1 stage should exceed 24 dB, and for this purpose the common-emitter current gain, β, of TR1 should be not less than 100.
11. Transfer the oscilloscope probe to the junction of the base of TR4 with C15 on the AM3/501. Measure the change in d.c. voltage at this point resulting from switching S1 from *0 V* to *—10 mV*. The change should be at least +0·9 volt. If this figure is not obtained, check that the driving pulses to the second bridge (D7 to D10) are satisfactory while temporarily earthing M2.
12. On the AM3/501, turn switch S1 to its central position and connect the oscilloscope probe to M2. Adjust RV3 to reduce the amplitude of the pulses on the oscilloscope to zero.
13. Transfer the oscilloscope probe to M2 on the AM18/508. Turn the *Clamp* switch, SB on this sub-unit, to the *Out* position. Depress the *Test* switch, SA, and check that a 50-c/s wave having a peak-to-peak amplitude of 0·5 volt ±10 per cent is superimposed on the output at M2 when the mains supply is 240 volts. (At a mains voltage other than 240 volts, the 50-c/s wave can differ proportionally.) Resistor R15 should be so selected that the 50-c/s wave is within the required limits.
14. Set the *Time Constant* switch S2 on the AM3/501, to *Med.* On the AM18/508, turn the *Clamp* switch from *Out* to *In* and measure at M2 the reduction in the 50-c/s wave which is superimposed on the output by the *Test* switch. The reduction in the 50-c/s wave should be 22 ±2 dB. If it is outside these limits, change C16 to obtain the required result. Finally, release the *Test* switch and return the *Time Constant* switch on the AM3/501 to *Short*.

15. Connect the oscilloscope probe to the output load. On the AM3/501, adjust RV1 and C18, and alternately readjust these controls as necessary, to make the blanking level constant over field blanking periods and line periods, and to reduce transients on the back porch to a minimum.
16. Transfer the oscilloscope probe to M2 on the AM3/501. Turn switch S1 on this sub-unit to the *0 V* position (by pressing the bar at the end bearing this marking). Readjust RV2 to bring the pulses at M2 to zero. Restore S1 to its central position.
17. Switch off the mains supply. Remove the chassis extender and fit the AM3/501 back in its normal position. Restore the mains supply. (Apply the sync input as before.)
18. Set the *Time Constant* switch on the AM3/501 to *Short*. On the AM18/508, measure at M2 the amplitude of the 50-c/s wave which is superimposed by pressing the *Test* switch, firstly while the *Clamp* switch is at *Out*, and then at *In*. The reduction in the 50-c/s wave should be 29 ±3 dB.
19. Check that the amplitude of the interference produced by the AM18/509 on the field-blanking and back-porch sections of the waveform at the output load is below the sync pulse amplitude by more than 39 dB. A Tektronix 545 oscilloscope with a Type-L amplifier unit is recommended for this measurement.

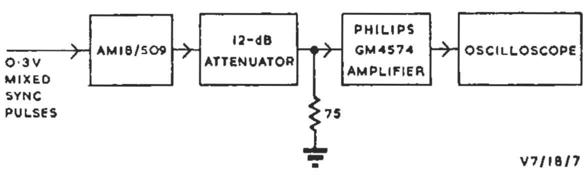


Fig. 18.7. Arrangement for Measuring Hum Produced by AM18/509

20. Check that the amplitude of the hum produced by the AM18/509 on the output waveform is below the sync pulse amplitude by more than 47 dB. An arrangement for making this measurement is shown in Fig. 18.7; the Philips GM4574 amplifier has a known gain of 100 and is protected against too great an input by the 12-dB attenuator.
21. Set the *Time Constant* switch on the AM3/501 to *Long*. On the AM18/508, measure at M2 the amplitude of the 50-c/s wave which is superimposed by pressing the *Test* switch, firstly while the *Clamp* switch is at *Out*, and then at *In*. The reduction in the 50-c/s wave should be 16 ±3 dB.
22. Replace the 405-line sync input to the AM18/509 by a 625-line 1T pulse and bar signal (preferably one without a standing d.c. component). Adjust L1 in the AM18/508 for optimum transmission of the signal as indicated by the oscilloscope connected to the output load.
23. Measure the 625-line 2T *k* rating of the AM18/509 by the routine test method. This should be less than 0·5 per cent.

Complete AM18/509A, AM18/509B and AM18/509C

Test and adjust an AM18/509B, or each of the two sections in an AM18/509A or AM18/509C, by the same procedure as previously given for the AM18/509.

Complete AM18/509D

Test and adjust each of the two sections in an AM18/509D by the same procedure as previously given for the AM18/509. Where tests at the output plug are necessary, operate the output switching relays to obtain the required output. For this purpose, apply 50 volts d.c. to pins 1 and 3 on PLB and connect a switch between pins 2 and 3.

When each section has been tested, apply the same signal to both input plugs by means of a distribution amplifier. With a 75-ohm load and an oscilloscope connected to the output plug of the equipment, switch on and off current to the output switching relays while examining the output waveform. No discontinuity should occur during the change-over in either direction.

Complete AM18/509E

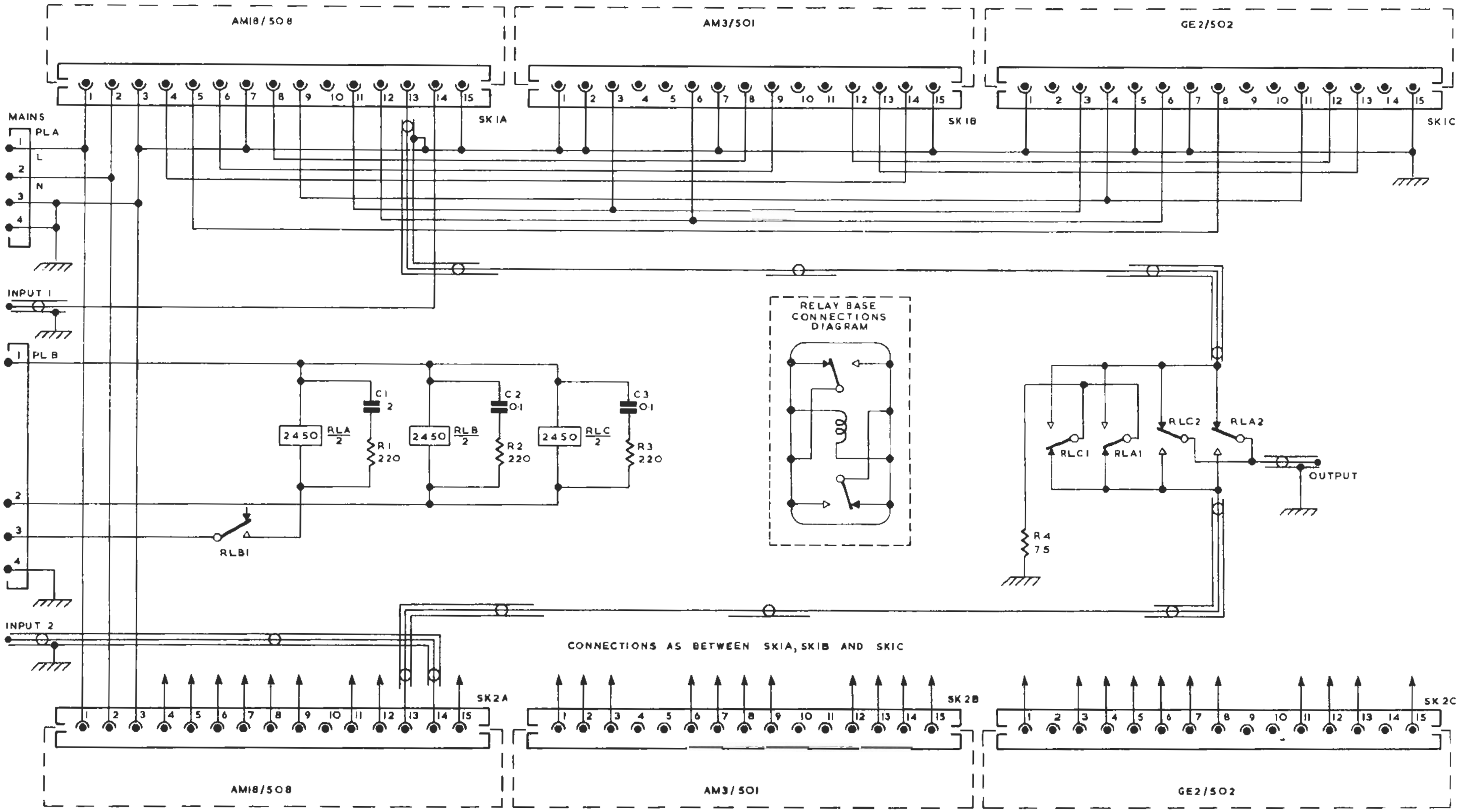
Initially, turn the *Video Input* switch on the UN3/507 to *Comp*, set the *Gain* control at *—3 dB*, and make all the tests and adjustments required on an AM18/509, as scheduled earlier. Then, in addition, proceed as follows:

1. Turn the *Gain* control to *0 dB* and measure the overall gain of the equipment while it is passing the pulse and bar signal. The output must be loaded with 75 ohms. The gain should be 0 ±0·25 dB.
2. Disconnect the signal lead from the video input plug and fit a 75-ohm load to this plug. Turn

the *Video Input* switch to *Non Comp.* Apply a mixed sync signal of nominally 2 volts peak-to-peak to the sync input plug and measure the amplitude of the sync pulses at the output load. This should be between 14·5 and 15·5 per cent of the actual amplitude of the input sync pulses.

3. Set the *Time Constant* switch on the AM3/501 to *Med.* On the AM18/508, measure at M2 the amplitude of the 50-c/s wave which is superimposed by pressing the *Test* switch, firstly while the *Clamp* switch is at *Out*, and then at *In.* The reduction in amplitude should be the same as that measured in operation 14 in the test procedure for the AM18/509 initially followed.

D.P.E.B. 12/64



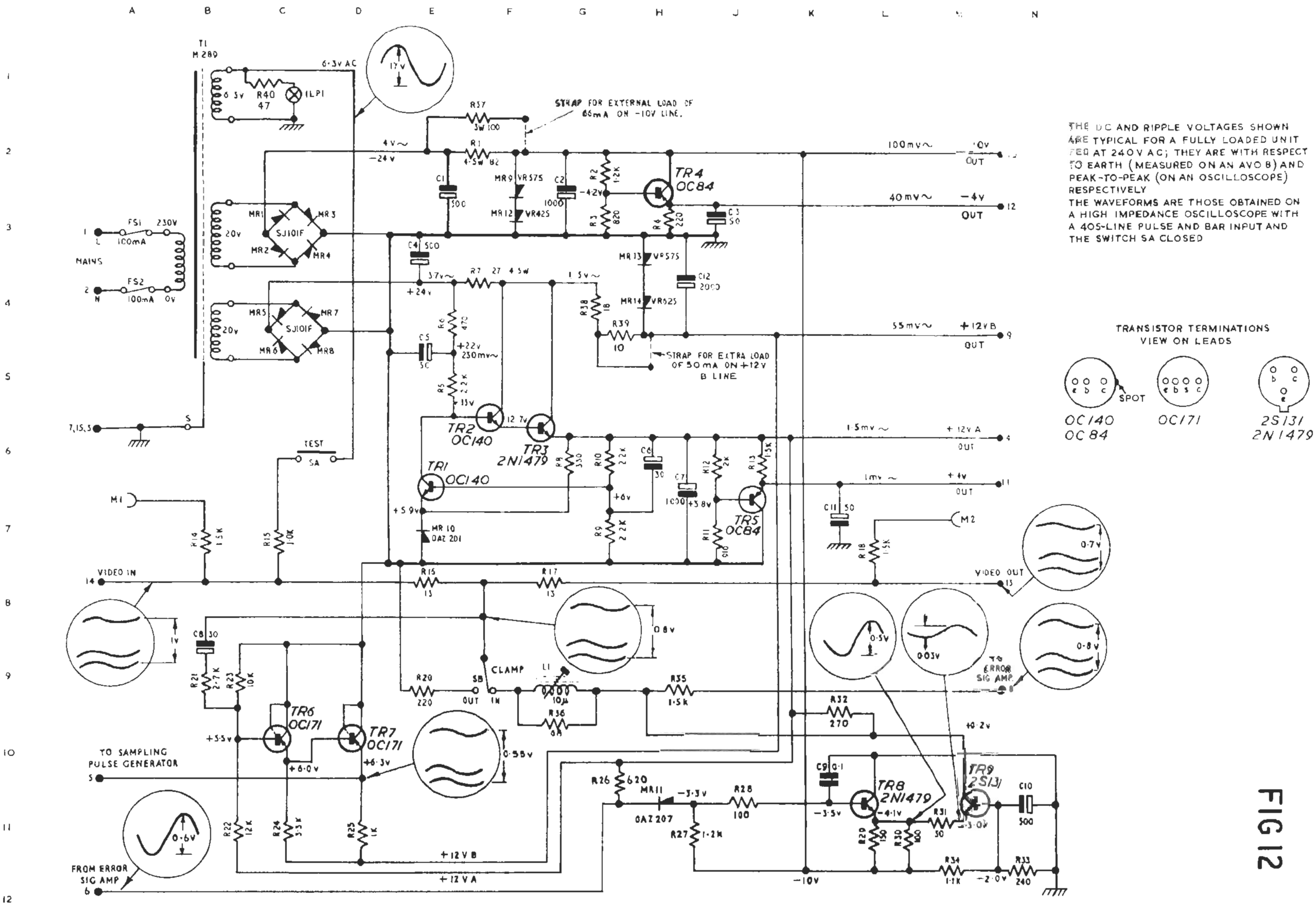
STABILISING AMPLIFIER AM18/509D : CIRCUIT

FIG 11

COMPONENT TABLE: FIG. 12

Comp.	Loc.	Type	Tolerance per cent
C1	E3	Hunt MEF.45T 50V	
C2	G3	Plessey CE1236/436 12V	
C3	J3	U.C.C. SM123S 12V	
C4	E3	Hunt MEF.45T 50V	
C5	E5	Plessey CE1201/439 25V	
C6	H6	U.C.C. SM65S 12V	
C7	H7	Plessey CE1236/436 12V	
C8	B9	U.C.C. SM65S 12V	
C9	K10	Hunt B500K	
C10	N11	Plessey CE1215/434 12V	
C11	K7	U.C.C. SM123S 12V	
C12	H4	Plessey CE1237/420 12V	
FS1	A3	Beswick TDP134/·100	
FS2	A4	Beswick TDP134/·100	
L1	G9	EA11717	
R1	F2	Painton P301A 4·5W	5
R2	G2	Erie 109 0·25W	2
R3	G3	Erie 109 0·25W	2
R4	H3	Erie 9 0·25W	10
R5	E5	Erie 109 0·25W	2
R6	E4	Erie 109 0·25W	2
R7	F4	Painton P301A 4·5W	5
R8	G6	Erie 16 0·25W	10
R9	G7	Erie 109 0·25W	2

Comp.	Loc.	Type	Tolerance per cent
R10	G6	Erie 109 0·25W	2
R11	J7	Erie 109 0·25W	2
R12	J6	Erie 109 0·25W	2
R13	J6	Erie 9 0·25W	10
R14	B7	Erie 9 0·25W	10
R15	C7	Erie 109 0·25W	2
R16	E8	Erie 109 0·25W	0·5Ω
R17	G8	Erie 109 0·25W	0·5Ω
R18	L7	Erie 9 0·25W	10
R20	E9	Erie 109 0·25W	2
R21	B9	Erie 9 0·25W	10
R22	B11	Erie 9 0·25W	10
R23	B9	Erie 9 0·25W	10
R24	C11	Erie 9 0·25W	10
R25	D11	Erie 9 0·25W	10
R26	G10	Erie 109 0·25W	2
R27	H11	Erie 109 0·25W	2
R28	J11	Erie 16 0·25W	10
R29	L11	Erie 108 0·5W	2
R30	L11	Erie 108 0·5W	2
R31	M11	Erie 109 0·25W	2
R32	K10	Erie 8 0·75W	10
R33	N12	Erie 109 0·25W	2
R34	M12	Erie 109 0·25W	2
R35	H9	Erie 9 0·25W	10
R36	G10	Erie 16 0·25W	10
R37	F2	Painton P301A 4·5W	10
R38	G4	Painton MV1A 1·5W	5
R39	G4	Painton MV1A 1·5W	5
R40	C1	Painton MV1A 1·5W	5



THE DC AND RIPPLE VOLTAGES SHOWN ARE TYPICAL FOR A FULLY LOADED UNIT FED AT 240V AC; THEY ARE WITH RESPECT TO EARTH (MEASURED ON AN AVO 8) AND PEAK-TO-PEAK (ON AN OSCILLOSCOPE) RESPECTIVELY.
THE WAVEFORMS ARE THOSE OBTAINED ON A HIGH IMPEDANCE OSCILLOSCOPE WITH A 405-LINE PULSE AND BAR INPUT AND THE SWITCH SA CLOSED

FIG 12

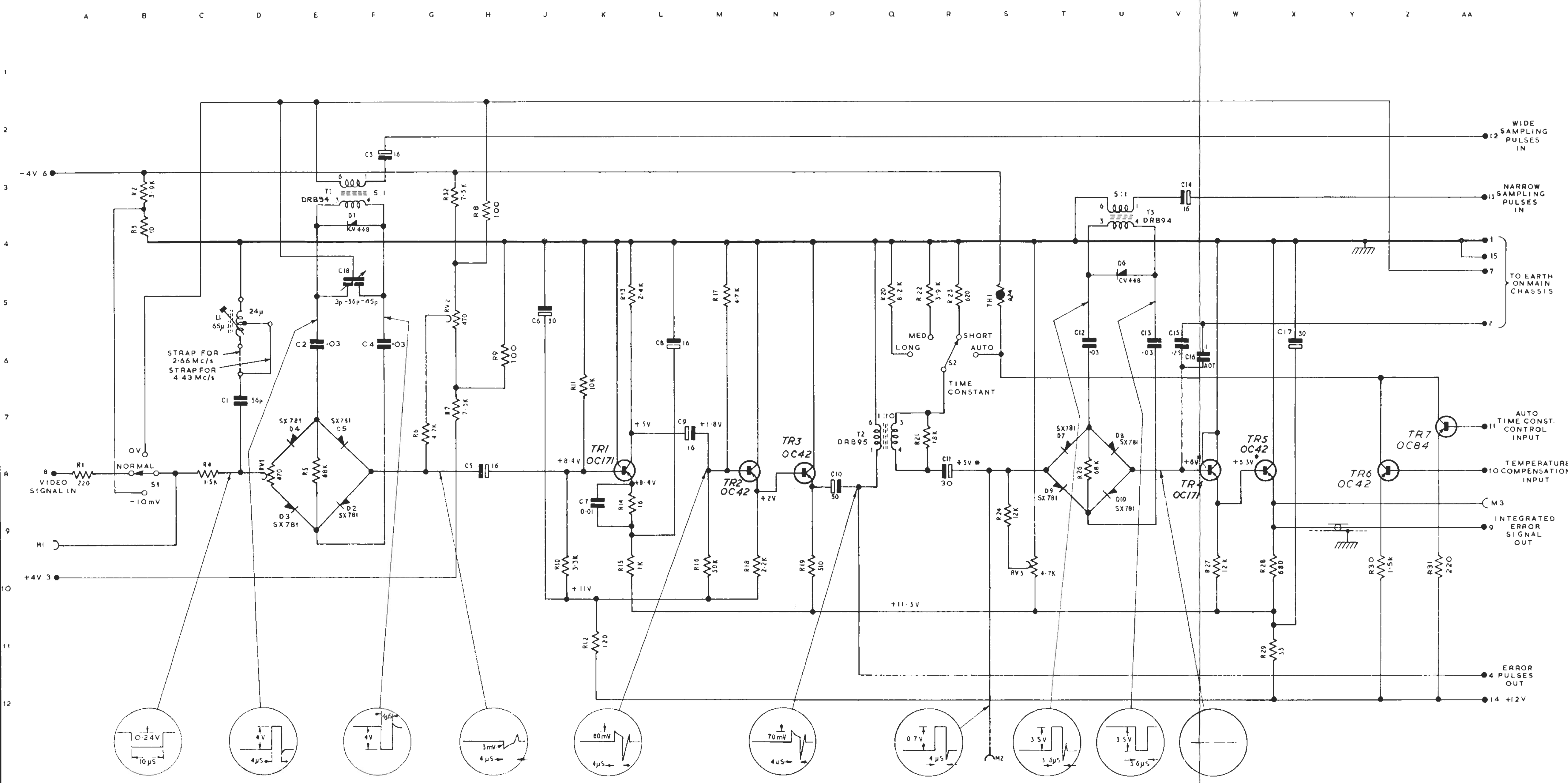
STABILISING AMPLIFIER AM18/508: CIRCUIT

COMPONENT TABLE: FIG. 13

Comp.	Loc.	Type	Tolerance per cent	Comp.	Loc.	Type	Tolerance per cent
C1	D7	Salford PF 125V	±2 pF	R8	H3	Erie 109 0·25W	2
C2	E6	Hunt BM15KV 250V		R9	H6	Erie 109 0·25W	2
C3	F2	U.C.C. SM62S 12V		R10	J10	Erie 109 0·25W	2
C4	F6	Hunt BM15KV 250V		R11	K6	Erie 109 0·25W	2
C5	H8	U.C.C. SM62S 12V		R12	K11	Erie 9 0·25W	10
C6	J5	U.C.C. SM65S 12V		R13	K5	Erie 109 0·25W	2
C7	K8	Hunt BM21KV 500V		R14	K8	Erie 109 0·25W	±0·5Ω
C8	L6	U.C.C. SM62S 12V		R15	K9	Erie 109 0·25W	2
C9	L7	U.C.C. SM62S 12V		R16	M9	Erie 109 0·25W	2
C10	P8	U.C.C. SM123S 12V		R17	M5	Erie 109 0·25W	2
C11	R8	U.C.C. SM65S 12V		R18	M9	Erie 9 0·25W	10
C12	T6	Hunt BM15KV 250V		R19	M9	Erie 109 0·25W	2
C13	U6	Hunt BM15KV 250V		R20	Q5	Erie 109 0·25W	2
C14	V3	U.C.C. SM62S 12V		R21	Q7	Erie 9 0·25W	10
C15	V6	Hunt B501K		R22	Q5	Erie 109 0·25W	2
C16	V6	Hunt B500K		R23	R5	Erie 109 0·25W	2
C17	X6	U.C.C. SM65S 12V		R24	S8	Erie 9 0·25W	10
C18	E4	Oxley		R26	T8	Erie 9 0·25W	10
				R27	W9	Erie 9 0·25W	10
				R28	W9	Erie 9 0·25W	10
L1	D5	EA11684		R29	X11	Erie 9 0·25W	10
				R30	Y9	Erie 9 0·25W	10
				R31	Z9	Erie 9 0·25W	10
R1	A8	Erie 9 0·25W	10	R32	G3	Erie 109 0·25W	2
R2	B3	Erie 109 0·25W	2				
R3	B4	Erie 109 0·25W	±0·5Ω				
R4	C8	Erie 9 0·25W	10	RV1	D8	Plessey 404/1/00142/471	
R5	E8	Erie 9 0·25W	10	RV2	G5	Plessey 404/1/00142/471	
R6	G7	Erie 9 0·25W	10	RV3	S10	Plessey 404/1/00142/472	
R7	G7	Erie 109 0·25W	2				

64/DPEB/003
DD8790

FIG 13



WAVEFORMS MEASURED WITH A HIGH IMPEDANCE OSCILLOSCOPE PROBE AND DC VOLTAGES ON A MODEL 8 AVO, WITH A 405-LINE PULSE AND BAR INPUT TO THE UNIT OF 0·8 VOLT PEAK-TO-PEAK, THE UNIT BEING CONNECTED IN THE FEEDBACK PATH OF AN AM18/509 AND SWITCHED TO SHORT TIME CONSTANT

* THESE POTENTIALS DEPEND ON THE SETTING OF RV3

TRANSISTOR TERMINATIONS VIEW ON LEADS

OC171

OC42 OC84

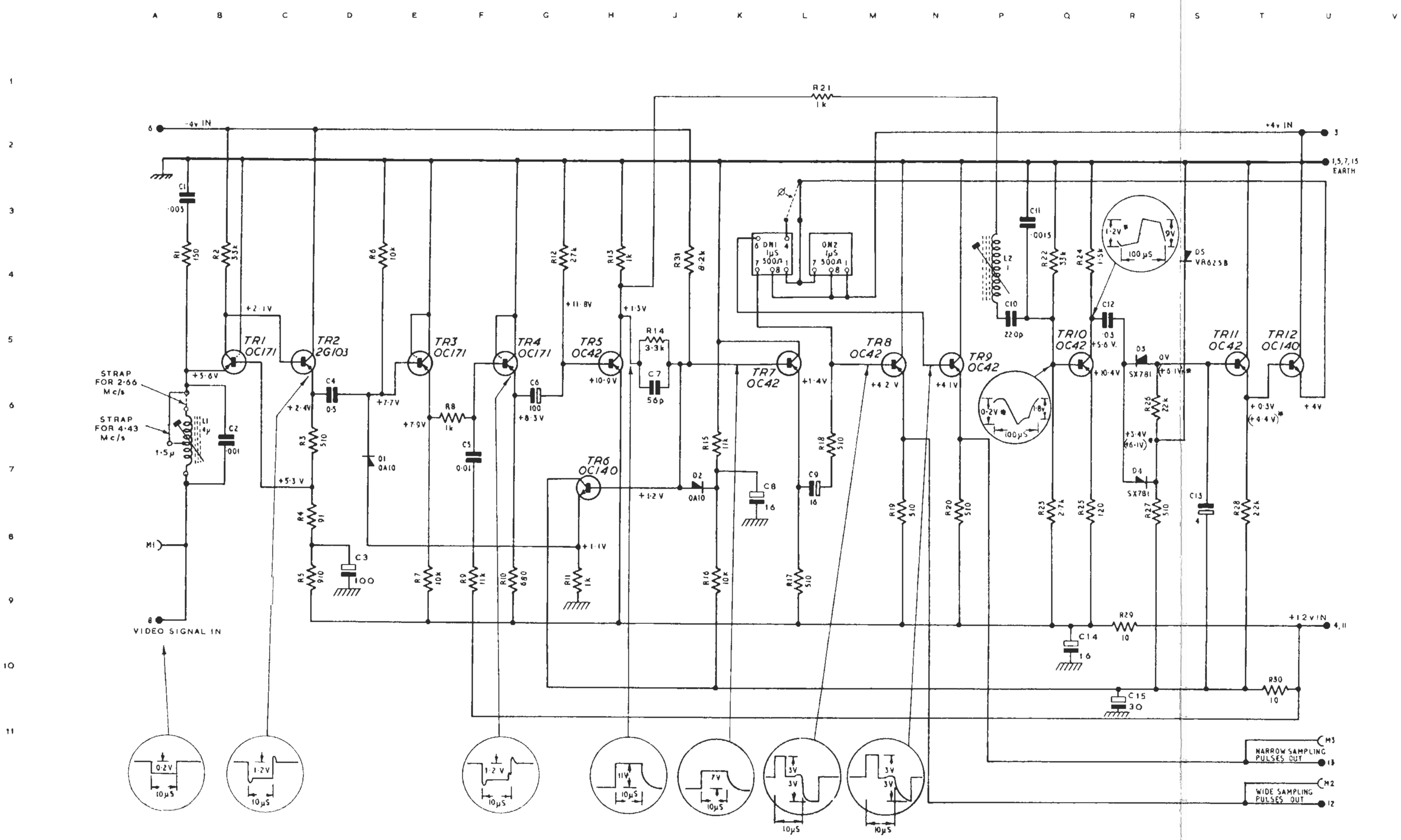
ERROR SIGNAL AMPLIFIER AM3/501 : CIRCUIT

AM3/501

COMPONENT TABLE: FIG. 14

Comp.	Loc.	Type	Tolerance per cent	Comp.	Loc.	Type	Tolerance per cent
C1	A3	Hunt BM20KV		R6	E4	Erie 9 0·25W	10
C2	B6	Salford PF 125V	2	R7	E9	Erie 9 0·25W	10
C3	D8	U.C.C. SC596/7LS 25V		R8	F6	Erie 9 0·25W	10
C4	D6	Hunt B502K 150V		R9	F9	Erie 109 0·25W	2
C5	F7	Hunt BM21KV		R10	G9	Erie 9 0·25W	10
C6	G6	U.C.C. SC596/7LS 25V		R11	G9	Erie 9 0·25W	10
C7	J6	Salford PF 125V	2	R12	G4	Erie 9 0·25W	10
C8	K7	U.C.C. SM62S 12V		R13	H4	Erie 9 0·25W	10
C9	L7	U.C.C. SM62S 12V		R14	J5	Erie 109 0·25W	2
C10	P4	Salford PF 125V	2	R15	K6	Erie 109 0·25W	2
C11	P3	Erie K120051/L	20	R16	K9	Erie 109 0·25W	2
C12	R4	Hunt BM15KV 150V		R17	L9	Erie 109 0·25W	2
C13	S8	U.C.C. SM56S 12V		R18	L7	Erie 109 0·25W	2
C14	Q10	U.C.C. SM62S 12V		R19	M8	Erie 109 0·25W	2
C15	R11	U.C.C. SM65S 12V		R20	N8	Erie 109 0·25W	2
				R21	L1	Erie 9 0·25W	10
				R22	Q4	Erie 9 0·25W	10
L1	A6	EA11727		R23	Q8	Erie 9 0·25W	10
L2	P4	21A/100		R24	Q4	Erie 9 0·25W	10
				R25	Q8	Erie 9 0·25W	10
				R26	R6	Erie 9 0·25W	10
R1	A4	Erie 9 0·25W	10	R27	R8	Erie 109 0·25W	2
R2	B4	Erie 109 0·25W	2	R28	T8	Erie 9 0·25W	10
R3	D6	Erie 109 0·25W	2	R29	R9	Erie 9 0·25W	10
R4	D8	Erie N6 0·125W	2	R30	T10	Erie 9 0·25W	10
R5	C9	Erie 109 0·25W	2	R31	J4	Erie N6 0·125W	2

FIG 14

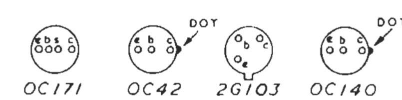


WAVEFORMS MEASURED WITH A HIGH IMPEDANCE OSCILLOSCOPE PROBE AND D.C. VOLTAGES ON A MODEL 8 AVO, WITH A 405-LINE PULSE AND BAR INPUT TO THE UNIT OF 0·65 VOLT PEAK-TO-PEAK.

✱ VOLTAGES MEASURED WITH A 625 LINE INPUT

Ø USE LINK IN THIS POSITION FOR 525 OR 819 LINE INPUT

TRANSISTOR TERMINATIONS VIEW ON LEADS

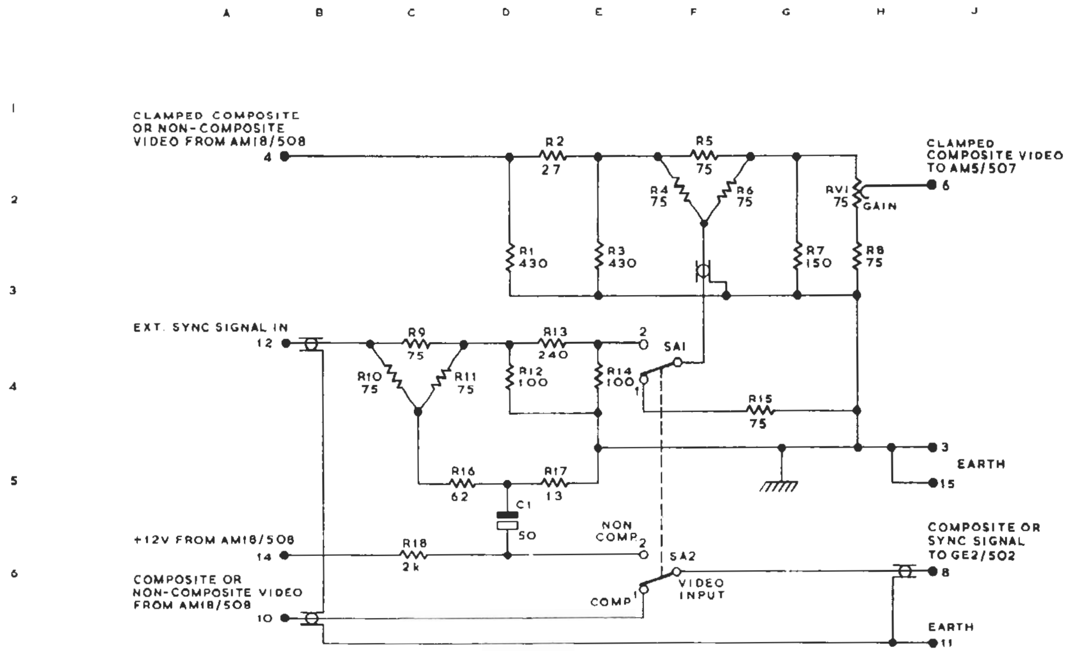


SAMPLING PULSE GENERATOR GE2/502 : CIRCUIT

COMPONENT TABLE: FIG. 15

Comp.	Loc.	Type	Tolerance per cent	Comp.	Loc.	Type	Tolerance per cent
C1	D5	U.C.C. SM123S 12V		R10	C4	Erie 109	2
				R11	C4	Erie 109	2
				R12	D4	Erie 109	2
R1	D3	Erie 109	2	R13	D3	Erie 109	2
R2	D1	Erie 109	2	R14	E4	Erie 109	2
R3	E3	Erie 109	2	R15	G4	Erie 109	2
R4	F2	Erie 109	2	R16	C5	Erie 109	2
R5	F1	Erie 109	2	R17	D5	Erie 109	2
R6	F2	Erie 109	2	R18	C6	Erie 109	2
R7	G3	Erie 109	2				
R8	H3	Erie 109	2				
R9	C4	Erie 109	2	RV1	H2	Plessey CP170301/31	

FIG 15



GAIN CONTROL UNIT UN3/507 : CIRCUIT